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A Summary of Current Program, 10/1/65 and Preliminary Report of Progress for 10/1/64 to 9/30/65

NATURAL RESOURCE ECONOMICS DIVISION

of the

ECONOMIC RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

and related work of the

STATE AGRICULTURAL EXPERIMENT STATIONS

This progress report of USDA and cooperative research is primarily a tool for use of scientists and administrators in program coordination, development and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of progress on USDA and cooperative research include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of USDA and cooperative research issued between October 1, 1964, and September 30, 1965. Current economic research findings are also published in the ERS publications Agricultural Economics Research, a quarterly, and The Farm Index, a monthly. This progress report was compiled in the Natural Resource Economics Division, Economic Research Service, U. S. Department of Agriculture, Washington, D. C. 20250.

UNITED STATES DEPARTMENT OF AGRICULTURE

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TABLE OF CONTENTS

INTRODUCTION

The Natural Resource Economics Division was formed in the Economic Research Service on August 10, 1965. The new Division encompasses and expands the functions of the Land and Water Branch and River Basin and Watershed Branch of the former Resource Development Economics Division. The Area Economic Development Branch of the RDED was transferred to the new Economic Development Division.

The Natural Resource Economics Division administers national and regional programs of research, planning and technical consultation and services on economic and institutional factors and policy related to use, conservation, development, and control of natural resources. The work is concerned with the extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic growth. It includes studies of resource requirements, development potentials, and resource investment economics. Ownership and tenure rights are included, as are also national, interstate, and local resource organizations, impacts of technological and economic change on the utilization of natural resources, resource income distribution and valuation, recreational use of resources, and the economics of man's use and management of his environment.

The Natural Resource Economics Division's structure is designed to develop and maintain an effective national and regional program of research and planning assistance on natural resource economics. It provides a logical grouping of research and planning assistance at both the Washington and field levels. The work is divided among four branches: (1) Land Resources, (2) Water Resources, (3) Resource Institutions, and (4) Environmental Economics. A Resource Data Systems Group was established in the Washington office to provide a single source within the Division for assembly, storage and retrieval of resource data and for assistance on data systems. Five regional field groups were formed to help plan and implement a coordinated Division field research and planning assistance program. Each Washington branch and each field group is arranged to facilitate direct interchange of ideas between personnel engaged in research and planning assistance activities.

Field studies generally are conducted in cooperation with State experiment stations or Federal and State resource development agencies. Close working relationships with both research and operational programs have long been traditional in this field. Close cooperation in planning and conducting work avoids duplication of efforts and provides opportunities for the direct application of research results.

Since progress was last reported, the Division has made a number of significant contributions to natural resource policies and programs. Division personnel have provided assistance to the Office of the Secretary, program administrators, the President's Water Resources Council, the U. S. House of Representatives Select Subcommittee on Real Property Acquisition, National Academy of Sciences, National Association of Soil and Water Conservation Districts, National Aeronautics and Space Administration, the Federal Council for Science and Technology, the White House Conference on Natural Beauty, the Recreation Advisory Council, the President's Appalachian Regional Commission, and others. Basic data and analyses provided by the Division have become increasingly important for policy implementation and program formulation. They have contributed to a better understanding of changes in the development, conservation, and use of natural resources, as they relate to agriculture, environment improvements, and other uses. Examples of research accomplishments contributing to natural resource policy and programs follow:

Land utilization program of the 1930's. A historical analysis of the origin, development, and accomplishments of the land utilization program of the 1930's shows that 11.3 million acres of submarginal farmland consisting of 37,000 tracts distributed among 250 projects were acquired by the government and converted to forests, grasslands, recreational areas, and wildlife refuges. In 1961, the primary uses of acquired lands were as follows: grazing, 7 million acres; forestry, 2.5 million acres; and special uses, including parks, wildlife refuges and related areas, 1.8 million acres. Multiple-use management is a standard practice. In addition to supplying grazing and timber, the grasslands and forests created from these projects provide recreational areas and wildlife habitat. Many projects are fulfilling program objectives by serving as demonstration areas for proper land management and conservation practices, by providing rural recreational areas and wildlife refuges, and by supplementing incomes of local people from grazing and forestry and through employment in project maintenance and operation. The study provides insights of value in designing and guiding future land retirement policies and programs.

State-owned rural lands. An inventory of the extent and use of State-owned land shows that in 1962 the 50 States, collectively, held title to almost 85 million acres of rural land. This research provides detailed information on this important and relatively unexplored area. Grazing and to a lesser extent farming and forestry, were the predominant uses of 58 million acres. The remaining 27 million acres were used for specific purposes such as parks and recreational areas, State forests, wildlife reserves, and institutional sites. The size of land holdings varied greatly among the States. Acreages were relatively large in most Western States, the Lake States, New York, Pennsylvania, Alaska, and Hawaii. Grants of land from the Federal Government were the means of ownership

for more than 60 percent of the State-owned land. Much of the remaining acreage was acquired through tax foreclosure and to a lesser extent by purchase.

Effects on cropping patterns of increasing water for irrigation. Research completed last year indicates that upgraded water supplies for irrigation in northern Colorado from the Colorado Big-Thompson trans-mountain diversion program were worth up to $38 per acre-foot in terms of increased values of farmland. In the project area, the acreage of irrigated wheat per farm increased by 9 percent, beans by 20 percent, sugar beets by 26 percent, and corn by 45 percent. The acreage of irrigated barley decreased by 15 percent. Alfalfa acreages remained about the same, but the amount of water applied per acre of alfalfa increased by about 85 percent--from a rate of 12.5 inches to 23 inches. Alfalfa accounted for about 54 percent of the irrigated land in the farms served by the project. About 75 percent of the increase in the total water supply was used for increasing hay production rather than crop output.

Irrigation in the Willamette Valley of Oregon. In this study of the yield response of field corn and bush beans to varying water inputs, data obtained from surveys were compared with data obtained from controlled physical experiments. The study indicates that the two data sources were sufficiently similar so that the results of controlled experiments may be considered by farmers as reliable guides for increasing production and improving the efficiency of water use. The study also indicates that the value of irrigation water for field corn production was relatively low in the Valley.

Returns to land and operator's labor. A study of the returns to the factors of production on selected types of Illinois farms indicates that part of operator's labor and management earnings had become embedded in land values by 1959. Comparisons between changes in land values and changes in the productivity of land in Illinois during the period from 1950 to 1959 indicate that land values have risen approximately 1.5 to 2 times faster than the increase in land productivity. The increase in land values during this period resulted in a decline in the rate of return on current land value from 11 percent in 1949 to 9 percent in 1954 and to 6.5 percent in 1959. Under a continuation of the general production and price relationships of 1959, operators will encounter difficulties in purchasing land from their share of farm earnings. The operator's disposable income in 1959, after deducting a 40-year annual installment for the purchase of land at 1959 prices, was less than the $3,000 poverty income level on all four types of farms under study. Disposable incomes were $1,400, $2,300, $1,700, and $2,600 for grain, hog, beef, and dairy farms, respectively.

Effect of tobacco allotments on distribution of farm income. A recent study indicates that the price-support acreage allotment programs have contributed to a more rapid increase in returns to land than to other factors of production. It also shows that tenure arrangements permitted landowners to capture most of the benefits of the tobacco programs. The annual return to the landlord for an acre of flue-cured tobacco increased from $29 in 1925 to $277 in 1960 for the North Carolina Plain, and from $14 in 1922 to $212 in 1960 for the Virginia Piedmont. These large increases in land rent were primarily the result of increases in tobacco prices and yields as a consequence of price-support and production control programs. The return to labor increased at only one-half the rate of increase in land rent over the comparable time period, and the return to capital increased at an even lesser rate. No important changes in crop sharing arrangements were necessary to enable the landlord to obtain this proportionally larger increase in return from the program. In part, this is explained by the fact that production items furnished by the landlord increased at a slower rate than did the production items furnished by croppers and tenants.

White and nonwhite owners of rural land in the Southeast. Nonwhites were about 12 percent of the 1.3 million individuals who in 1960 owned rural land in the States of Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, and Virginia. The 160,000 individuals owned over 8 million acres of land, or about 7 percent of all individually owned rural land in the Southeast. About 70 percent of the nonwhite landowners held land as sole owners compared with 84 percent for white owners. The remaining 30 percent nonwhite owners and 16 percent white owners shared their interest in land with other owners. Inheritance of a full or part interest in land was a more important method of acquisition among nonwhites than among whites. More than half of the nonwhite landowners acquired at least some of their holdings by inheritance compared with two-fifths of the white owners. Nonwhites had a lower rate of turnover in landownership. White owners acquired and sold considerably more land than did nonwhites, and they usually transferred larger acreages.

Operations of proportional-profit farms in Puerto Rico. The Land Law of Puerto Rico, approved in 1941, authorized acquisition of corporate-owned lands in excess of 500 acres and provision of homesites to landless agricultural workers. Proportional-profit farms were established which must distribute all profits to the farmworkers in proportion to wages earned during the year. Analysis of the farms for the period 1950-1961 indicates that output of sugarcane per acre and labor inputs per ton of cane harvested compare favorably with privately operated farms. During the period analyzed, the publicly operated farm system increased productivity at a faster rate than the private sector. Profits distributed during the period were about 11 percent of total wage payments. This research provides insights as to land reform arrangements of possible use to other countries.

Legal-economic analysis of contract farming. A study of 420 contracts used between farmers and processors or farm supply businesses shows that contracts for hybrid seed corn production and broiler production transferred the greatest amount of management control from the farmer to the contractor. Most contracts were prepared by the contractor and presented to farmers with little opportunity to make changes. Contracts showed little standardization, either by product or geographic area. Production for market specifications was a key factor in many of the contracts. Many of the contracts transferred management control to the contractor without the latter's acceptance of commensurate responsibility or uncertainty. For example, forward pricing was the usual pattern but some contracts put the farmer in a more precarious price situation than the open market. Some contracts permitted the contractor to refuse to accept the product without any restrictions. This research should lead to improvements in contract arrangements between farmers and processors or farm supply businesses.

Special districts in the United States. The number of active special districts in the United States, including natural resource districts, more than doubled during the 20-year period from 1942 to 1962. The number increased from 8,299 to 18,323. Soil conservation, health, and water supply districts all increased more than four times. During the same time period, the number of natural resource special districts increased from 3,719 to 8,358, more than double. Natural resource districts include those for drainage, soil conservation, irrigation and water conservation, flood control, water supply, parks and recreation, other natural resources, and multifunction districts. While special districts are found in every State, they tend to be concentrated in some States such as Illinois and California, each of which has over 12 percent of the natural resource districts and over 10 percent of all special districts. Studies of special district enabling laws in Oklahoma reveal that democratic processes and legal and financial powers were clearly expressed, but that more provisions could be specified for State agency review, for intergovernmental coordination, for project feasibility analysis, and for amending, dissolution and mergers.

Preserving open space in urbanizing areas. A survey of representatives of agriculture and planning agencies in California indicates that possibilities are limited for maintaining substantial privately owned tracts of open space in farming or other extensive uses in metropolitan areas. The three "agricultural cities" in Los Angeles and Orange Counties have been dissolved as a result of such pressures as demands for school sites, rising school district assessments, and increasing real estate values. So far, planning efforts (including "greenbelting," exclusive agricultural zones, changes in assessment practices and tax policies) to save farms and open lands adjoining urbanizing areas have only postponed eventual development. Those contacted showed little interest in public purchase of development rights or other easements to preserve open space. These

partial rights were viewed as costing too much while not providing adequate public control of the land uses.

Methods and techniques of analysis for river systems planning. Comprehensive river basin planning is currently handicapped by the difficulty of applying adequate systems of economic analysis and of improving planning methodology. Consequently, a number of investigational efforts were undertaken or extended during the year to improve the analytical techniques of river systems planning. Considerable attention was devoted to the extension and adaptation of a minimum-cost linear programming technique as (1) a technique for interregional and subregional agricultural output and land use projections, and (2) a method for evaluating long-range economic impacts of water development alternatives.

Analysis and projection of water development in regional economic activity. Widespread water shortages in recent years, some of them quite dramatic, have focused public attention on water problems, supplies, and uses. These water shortages emphasize the critical importance of seven ongoing and emerging broad-gauged framework studies to provide essential guidelines for the best regionwide use, or combination of uses, of water and related land resources to meet foreseeable short- and long-term needs. Six framework studies in which ERS is a major participant are now underway in the Ohio, Upper Mississippi, Missouri, New England, Susquehanna-Chesapeake, and Colorado River Basins. A seventh framework study, the Columbia-North Pacific Basins, was started during the reporting year and is still in an initial phase of progress and accomplishment.

Secondary impacts resulting from watershed project installation. Increased research emphasis was given to understanding and analysis of secondary impacts from installation of watershed projects. Studies in Pennsylvania were devoted to the collection, assimilation, and evaluation of statistical data for over 20 different industrial classifications. Additional research encompassed a comparison of sector analysis of existing input-output studies. It provides insights for the possible development of a synthetic model for use in appraising economic impacts of watershed projects.

AREA NO. 1. ECONOMICS OF LAND UTILIZATION

Problem. Population growth, advances in agricultural production technology, changing consumer demands, and other factors combine to cause changing demands for the Nation's fixed supply of land. Analyses of current levels and trends in the major uses of land, of the economics of land development and conservation measures, and of the need for land use shifts provide the basis for informed policies and programs on land use adjustments and the conservation and development of land resources.

USDA AND COOPERATIVE PROGRAM

Research in the economics of land utilization is divided into two subareas: (A) inventory and appraisal of land supplies and uses; and (B) land requirements, conservation and development. This research provides a continuing inventory of major land uses, both farm and nonfarm, regional and national; as well as analyses of trends in type and intensity of land use by States and regions. It includes shifts in major agricultural uses and acreages absorbed by nonagricultural uses. The research also evaluates alternative methods for acquiring data on uses and potentials of land resources. It appraises historical programs of cropland retirement and conversion as a basis for decisions relating to current problems of land use. Further, it evaluates the need for land conservation and development measures, the adequacy of the land-resource base for projected national agricultural output requirements and nonagricultural land needs, and resulting implications for patterns of production.

Research in this area is both basic and applied. The nature of the research makes it necessary to draw upon several scientific disciplines, including economics, statistics, geography, soils, botany, agronomy, forestry, and photogrammetry. Research in this area is financed by directly appropriated funds and by transfer funds from the National Aeronautics and Space Administration. During the reporting year, research was conducted in cooperation with the Virginia Agricultural Experiment Station and by contract with the Purdue Research Foundation. Informal cooperation was maintained with many State and Federal agencies, and other organizations.

Approximately 5.3 professional man-years were devoted to this area during the reporting year. This included non-Federal professional personnel working under cooperative agreement and contract.

PROGRAM OF STATE EXPERIMENT STATIONS

The State stations' research in this area is somewhat more localized and more on a problem basis than that carried out by ERS. Thus, the two programs supplement each other. Some of the research analyzes the economic potential for adjustment to new technology, economic conditions possessed by each of the major land classes, and resource combinations necessary for the operators to achieve specified minimum incomes. For such analyses, the State may be divided into homogeneous areas based upon soils, climate and other characteristics. In the Western States, studies are made of policies and practices that result in success under the Desert Land Entry Act and of uses of State and Federal lands in conjunction with private land operations, including rentals or fees charged.

Throughout the Great Plains and all of the Eastern States, farm population continues to decrease. Studies are made of the extent to which farm enlargement or land abandonment are causes, the extent and nature of the land use shifts, and the human and community adjustment problems that result. Some State projects are designed to develop long-range land use plans for the State based upon projected demands for products and changes in comparative advantages between States.

Because of the growing interest in outdoor recreation, several States have projects concerning possibilities for multiple land use and the practices used by forest land owners who permit the public to camp, hunt and fish on their lands. Studies also cover problems encountered by owners. Funds available under the McIntire-Stennis Act provide the basis for more research on economics of forest-based recreation and development of standards for identifying and managing wilderness areas.

A total of 6.0 professional man-years is devoted to this area of research.

PROGRESS--USDA AND COOPERATIVE PROGRAMS

A. Inventory and Appraisal of Land Supplies and Uses

Maintenance of data series shows that the acreage of cropland used for crops totaled 334 million acres in 1964. This total was down a little from the 336 million acres the previous year, and near the record low of 330 million acres used in 1962 and in 1910, the first year for which data are available. The greatest regional change occurred in the Northern Plains, where land used for crops decreased 0.9 million acres from 1963. Except for an increase in the Delta States, acreages in other regions were either down slightly or unchanged from 1963.

Research was conducted to identify the best types of aerial photography for purposes of land use identification and to develop interpretive keys. Photographs of the Purdue Experimental Farm obtained in 1964 were used for interpretation and for correlating photographic tone with crop conditions. Much tonal variation occurs within the same crop species, these variations being more marked at certain periods during the growing season, and more distinct in some wavelength bands than in others. Factors which appear to account for photographic tonal variation within crop species include (1) variety of crops; (2) relative maturity; (3) geometry of the crop as influenced by plant height and growth characteristics, population density and planting configuration, lodging, etc.; (4) cultural practices, such as tilling, irrigation, and certain fertilization and spray treatments; and (5) soil type and associated characteristics such as color, texture, and moisture content of the surface soil. Variations in tonal response indicate a need for further experimentation before photographic tonal signatures uniquely associated with each crop can be determined.

During the reporting period, research to assess potential economic benefits of making resource surveys from earth-orbiting satellites was initiated under a transfer of funds from the National Aeronautics and Space Administration. A review of literature was conducted and experimenters in remote sensing techniques were consulted to determine what useful physical and biological phenomena are detectable from satellite altitudes. The phenomena likely will be limited to land, water, terrain topography, vegetative types, vegetative stand and vigor, soil surface materials, animals, surface or near-surface heat extremes, clouds, and cultural objects. A list of potential agricultural applications was compiled for subsequent benefit analysis. A tentative observation resulting from work done so far is that imagery from a sensing system must permit consistently accurate identification of vegetative types, measures of vegetative vigor, and accurate area measurements for the realization of significant agricultural benefits.

A study of the land utilization program of the 1930's and an inventory of the extent and use of State-owned lands, both for which progress was reported last year, have been completed. Reports of the findings were published.

B. Land Requirements, Conservation, and Development

A draft manuscript on the uses of aerial photography for rural and urban planning has been completed. This manuscript discusses applications of photo interpretive and photogrammetric methods to planning. For example, relatively simple photogrammetric methods may be used to determine such things as acreage in fields, length and slope of shoreline at a site proposed for a waterfront park, number of square feet and approximate

number of parking places in a parking garage, and height of trees and buildings in airport approach and takeoff lanes. Both topographic and planigraphic maps, used extensively by planners, may be quickly compiled and brought up-to-date by photogrammetric methods. Photo interpretation methods may be used for such diverse purposes as traffic counts, inventories of natural resources, studies of watershed drainage patterns, highway site selections, and estimates of rate of change from rural to urban land uses.

A land use and ownership study was initiated through cooperative agreement with the Virginia Agricultural Experiment Station. The objectives of this study are (1) to determine physical; economic, and institutional factors that influence changes in land use and ownership; (2) to develop procedures for measuring relevant variables and to quantify the effects of each on the utilization of land and labor resources in selected Appalachian areas; and (3) to evaluate alternative policies for ameliorating the economies of the selected areas in terms of current resource utilization patterns.

Computations have been completed for a highly aggregative model defining regional patterns of land use resulting from various objective functions and resource restraints. A manuscript presenting the results of this work is being prepared.

Assistance was provided in analyzing data from the 1958 National Inventory of Conservation Needs. A committee report summarizing information by the 10 Farm Production Regions was published. Personnel are actively participating in developing plans for a revision of this inventory. This revision will involve two separate activities (1) an appraisal of watershed project needs; and (2) a comprehensive reinventory of land use, conservation problems, and treatment needs.

AREA NO. 1.--ECONOMICS OF LAND UTILIZATION

PUBLICATIONS--USDA AND COOPERATIVE PROGRAMS

A. Inventory and Appraisal of Land Supplies and Uses

Wooten, Hugh H. 1965. The Land Utilization Program of 1934-1964, origin, development, and present status. Agr. Econ. Rpt. No. 85. U. S. Department of Agriculture. 85 pp.

Frey, H. Thomas. 1965. State-owned rural land, 1962. Statis. Bul. No. 360. U. S. Department of Agriculture. 11 pp.

Changes in farm production and efficiency--a summary report. 1965. Statis. Bul. No. 233. U. S. Department of Agriculture. pp. 17-20.

Supplement II to changes in farm production and efficiency--a summary report. 1965. Statis. Bul. No. 233. U. S. Department of Agriculture. 7 pp.

B. Land Requirements, Conservation, and Development

Soil and water conservation needs--a national inventory. 1965. Misc. Pub. No. 971. U. S. Department of Agriculture. pp. 20-30.

Pendleton, William C. 1965. An empirical study of changes in land use at freeway interchanges. Traffic Quarterly. Vol. XIX, No. 1. pp. 89-100.

AREA NO. 2. ECONOMICS OF WATER UTILIZATION

Problem. The efficiency with which ground and surface water resources are managed in the agricultural sector of the economy has a direct bearing on the contribution of natural resources to economic growth. Modest gains in the efficiency of agricultural water use will result in substantial increases in supplies effectively available for all uses, particularly in Western regions where irrigated agriculture is an important segment of basin economies and water supplies are already inadequate for all beneficial purposes. Continued expansion of irrigation in the East and nationwide water pollution problems make the economic management of water in agriculture an important factor in balanced development and growth of all water-using industries, including agriculture itself.

USDA AND COOPERATIVE PROGRAM

Current investigations are concerned both with providing economic facts on water supplies, uses, and management needs as they concern farmers, legislators, or administrators, and with analyzing the resulting implications for water management decisions. Intensive studies are concerned with developing economic principles and techniques appropriate to the analysis of agricultural water problems, including special problems of water quality management and ground water conservation. Also conducted are regional inventories of agricultural water supplies and uses and studies of the water values or price-equivalents necessary for determining the feasibility and profitability of new water supply technologies or management practices, watershed projects, and broad river basin programs. The research program is discussed here under two subareas: (A) Inventory and appraisal of water resource supplies, uses, and values; and (B) water requirements, allocation, and conveyance efficiencies. About 55 percent of this present research might be termed basic economic research, with the remaining 45 percent representing applied economic studies and data-collection activities necessary for both basic and applied studies.

Subject matter fields involved in addition to economics include hydrology, agronomy, engineering, statistics, and law. In addition to program leadership, about one-third of the research effort in the year past has been centered in Washington, D. C. These studies included analyzing and interpreting basic source material on current and estimated future water use in relation to supplies; developing improved techniques for evaluating watershed and river basin development projects; accumulating regional data on available land and water resources classified by productivity; and analyzing regional irrigation trends and potentials.

New research on the economics of agricultural water quality management, with emphasis on pesticide problems, was concentrated in Washington, D. C., with some exploratory work in the North Central region. New research on water quality is scheduled in both the North Central and Pacific Northwest regions. Assuming additional funding, plans are being developed for the following studies: (1) economics of erosion and sedimentation processes in the Lower Mississippi States, emphasizing upland management practices and resulting on-site and off-site damages; (2) irrigation potentials in the Appalachian region, emphasizing water-supply considerations and vertical coordination possibilities; (3) water-based recreational enterprises in Appalachia; (4) irrigation efficiencies and dryland moisture conservation in the Northern Plains; and (5) rural-urban water problems and possibilities for improved management of irrigation water in Hawaii.

Direct cooperation with nearly all States is maintained through ERS participation (with membership and/or contributing projects) in the activities of regional committees interested in the economics of agricultural water management. ERS has developed, and is currently conducting, irrigation research for a North Central regional project on economic and legal factors in agricultural water use. An ERS scientist serves on a reimbursable basis as the regional coordinator for this study involving 12 States. The ERS is also participating in a Western regional study of legal-economic aspects of water reallocations or transfers between agricultural and competing water uses. The Southern Land Economics Research Committee has a Subcommittee on Water Resources through which ERS has coordinated its research plans and activities involving water management in the South.

The total research effort in the economics of water utilization has been equivalent to about 6 professional man-years for this reporting period.

PROGRAM OF STATE EXPERIMENT STATIONS

Several of the Western States are concerned with the increase in demands for water in areas where water has been dedicated to agricultural use and this use is safeguarded through laws and other institutional means. This traditional water allocation may detract from the best interests of the community and may retard developments other than agricultural. The States are developing information to show the marginal value of water for various uses. In some areas where water is plentiful, the tendency is to use too much water to save on labor costs. This may result in poor drainage and lowered yields. The research is designed to determine optimum combinations of water, labor and capital. Local studies are made to evaluate the water supply situation in local areas, the economic

impact of proposed development upon the agricultural economy of the area, the changes in farming methods and systems required to convert from dryland to irrigated farming, and the extent to which dryland and irrigated agriculture may be combined for a more stable income flow. Problems of water losses in conveyance, including the economics of piping and the lining of ditches, are being studied.

Attempts are being made in the Eastern States to determine the value of water in agricultural, recreational, industrial and residential uses. Limited amounts of research involve possibilities of safeguarding crop yields in dry years or dry seasons through irrigation and the input-output relationship of such practices. Costs of water pollution problems and how these may be overcome have been considered.

A total of 9.5 professional man-years is devoted to this area of research.

PROGRESS--USDA AND COOPERATIVE PROGRAMS

A. Inventory and Appraisal of Water Resource Supplies, Uses, and Values

Research in water quality management was initiated, through a mail survey, to examine relationships between farming operations and water quality. The survey was conducted over the United States and was addressed to the principal water pollution control agencies and agricultural experiment stations of each State. Responses were received from 34 State administrative agencies and 33 agricultural experiment stations, covering 43 States. The responses indicate that farming-caused water pollution is widespread. It is not universal, however, and in many cases is attributable to specific circumstances. Although pesticide problems were reported in 21 States, recurring problems seem to be concentrated in certain areas. Problems of farmyard waste effluent, reported in 23 States, were of a local nature in most instances. Because of the growing trend toward keeping large numbers of farm animals in confinement, the problem of farm waste disposal will grow in importance. Detrimental effects from fertilizer in runoff, reported in 12 States, were not well substantiated. Stream turbidity and sedimentation were reported as definite problems in 15 States. They appear to be significant in others. All the reports indicate a close relationship between land use and cultural practices, storm runoff, and a wide variety of possible chemical pollutants. Future ERS research will include evaluation of benefits and costs of individual control measures, and development of analytical approaches that consider the broader environmental effects of pollutants on soil, water and atmosphere. Immediate plans are to initiate a technical-economic study of pesticide residues in rural water supplies in the North Central States and an economic-institutional study of water quality management in the Pacific Northwest.

In connection with appraisals of agricultural water uses and supplies, an administrative basebook on rural and urban water uses in 1960 in the U. S. was revised in some minor respects. Collation of water requirement data specific to various crops in each of the 24 major water resource regions is now underway. This report is essentially a digest of Geological Survey, Census Bureau, and other information available as of 1959 or 1960. The Geological Survey is updating its State and regional summaries of various withdrawal and consumptive uses to a 1965 base. The ERS staff likely will be asked to contribute its basic information on irrigation and other rural water uses to the periodic inventory programs of the Geological Survey.

Some exploratory research has been completed on methods for quantifying the sensitivity of regional irrigation development to alternative national reclamation and other resource development policies. Two initial inferences are (a) that irrigation development in the U. S. as a whole is still increasing geometrically in terms of statistical growth functions; and (b) that definite national policies on further development are needed if acreages for future years are to coincide reasonably with future economic needs. Similar research for selected North Central States was completed as part of the ERS contribution to a North Central regional research project on the economics of agricultural water use.

Studies of irrigation and competing water uses in Colorado have focused on two items related to the Colorado-Big Thompson (CBT) transmountain diversion project: (1) emerging rural-domestic water supply districts and competitive pressures for reallocation of water previously used exclusively for irrigation; and (2) onfarm managerial adjustments to increased irrigation supplies. About 10 organizations, 9 dependent on CBT water, have been organized in Boulder, Weld, and Larimer Counties, north of Denver in the past several years. Their operations have been the major reason that the value of CBT allotments increased to about $135 per acre-foot in 1964 from a transfer price of $40 per acre-foot in 1960. Nearly 4 percent of total CBT deliveries to the area have been diverted to nonirrigation purposes.

Managerial adjustments involving the remaining 96 percent of CBT deliveries have been studied. The results were published in a technical bulletin prepared in collaboration with the Colorado Experiment Station. Generally, farms have been enlarged somewhat and farmers have irrigated more land. More land is planted to intensive row-crops with high-water requirements and fewer acres to low-value short-season crops. Yield increases were reported on all crops grown. More water was applied to all crops grown, particularly to row crops and alfalfa.

Twice as many farmers have used fertilizers since CBT water became available. They also fertilized more heavily. Many farmers were making new capital improvements on farms. These averaged $9,700 per farm. Improvements to land and to irrigation systems averaged almost $5,000 per farm and improvement and replacement of machinery averaged around $7,000. Farmers anticipating further investments intend to spend an average of $4,500 on improvements.

Of the supplemental water used on farms, 78 percent was in increased applications, 11 percent went to changes in crops grown, and 10 percent to changes in both rates of application and crops grown. Somewhat over 75 percent of the increased water supply is used for producing alfalfa.

Alternative methods of valuing irrigation water used were developed for the Willamette Valley of Oregon. A technical bulletin is in press. Three valuation methods were compared: Production function analysis using survey data, production function analysis using data from controlled experiments, and mathematical programming. Data for 1963 and 1964 were obtained from two basic sources: (1) A survey of producers growing field corn for grain and bush beans in Benton,Linn, Marion, and Polk Counties of western Oregon; and (2) experiments using controlled irrigation for the same crops and general soil conditions. A close similarity existed between survey and experimental functions over the survey range of the water inputs. Therefore, it appears that farmers can rely on results of controlled experimental work as guidelines for increasing production and for efficient use of water resources. An hypothesis of the marginal nature of irrigated field corn production in the Valley was substantiated. Empirical estimates of unit values of water used to irrigate corn and beans will be reported after further study.

B. Water Requirements, Allocation, and Management Efficiencies

During the past year, shortage of personnel has delayed research on the economics of watershed management, informally cooperative with the ARS Blacklands Experimental Watershed at Waco, Texas. The project has been continued in hope that work can be done there soon. Completion of the report on the economics of water conveyance in California also has been delayed.

Concerning research on land forming for water management in the Eastern States, a terminal technical bulletin is now in draft form. It will be published by either the ERS or the Iowa Station. The report reviews the historical development of such land forming techniques as land grading, shaping, special terracing, bedding, and crowning. It presents a conceptual framework for rigorous economic appraisal of these techniques. It demonstrates the utility of mathematical programming as a guide to optimal investment decisions. This study very strongly confirms that a multidisciplinary approach to economic evaluation of land forming is

needed. Required information on benefits was almost totally absent--even in areas (as the Lower Mississippi States) where the practices have been widely adopted.

Various concepts of industrial dynamics conventionally applied to industrial organizations by systems engineers have been examined for their adaptation to economic planning of river basin development. Simulation, as one such concept, was applied by ERS and Oregon State University to problems of planning in the Calapooya tributary of the Willamette River. The activity has generated interagency interest in applications to the general problems of comprehensive water resource planning in the Willamette, Puget Sound, and Columbia Basins.

More recently, the ERS has undertaken a short-term cooperative study with Harvard University on possibilities for using simulation techniques to compare alternative operational strategies and water delivery routines of irrigation organizations in California, Colorado, and other selected areas.

Another newly initiated study, with Texas Technological College, will develop an optimal ground water management program for the High Plains. Emphasis will be on optimal management as a means of balancing objectives for a high level of sustained economic activity.

AREA NO. 2. ECONOMICS OF WATER UTILIZATION

PUBLICATIONS--USDA AND COOPERATIVE PROGRAMS

A. Inventory and Appraisal of Water Resource Supplies, Uses, and Values

Anderson, Raymond L., 1965. Emerging nonirrigation demands for water. Agricultural Economics Research 17(4). 14 pp. October.

Gertel, Karl, 1964. Economic potentials of irrigation in North Carolina: based on soil classification and acreage estimates from the National Inventory of Soil and Water Conservation Needs. ERS 187. 35 pp. December.

Pavelis, George A., 1964. Regional consequences of alternative policies for irrigation development. Bulletin of the Operations Research Society of America, Vol. 12, 1964. (Supp. 2) p. B-179.

Pavelis, George A., 1965. Irrigation policy and long-term growth functions. Agricultural Economics Research 17(2): 50-60. April.

U. S. Dept. Agriculture, 1965. Soil and water conservation needs--a national inventory. Misc. Pub. 971 (See esp. pp. 77-89 on watershed project needs).

B. Water Requirements, Allocation, and Management Efficiencies

Anderson, Raymond L., and Hartman, L.M. 1965. Introduction of supplemental irrigation water: agricultural response to an increased water supply in northeastern Colorado. Colo. Agr. Expt. Sta. Tech. Bul. 76. 34 pp. June.

Halter, Albert N., and Miller, Stanley F., 1964. Simulation systems in making water resources decisions. Proc. Comm. on Econ. of Water Res. Dev., Western Agr. Econ. Res. Council, San Francisco, Calif., December, 1965.

Miller, Stanley F., Castle, Emery N., and Boersma, Larry L., 1965. Irrigation water values in the Willamette Valley: a study of alternative valuation methods. Oregon Agr. Expt. Sta. Tech. Bul. 85.

Steele, Harry A., and Pavelis, George A., 1965. Economics of irrigation policy and planning. Chapter 11 in Irrigation of Agricultural Lands, a compendium published by the American Society of Agronomy.

AREA NO. 3. RESOURCE TENURE INSTITUTIONS

AREA NO. 3.A. LEGAL-ECONOMIC ASPECTS OF LAND AND WATER USE

Problem. Efficiency in use of land and water resources is conditioned by laws, administrative measures, and related institutional arrangements that prescribe the rules and procedures for transfer, use, and management of resources. Rapid rates of population growth and urban expansion, imbalances in agricultural supply and demand, and technological change necessitate improved measures to achieve an orderly and balanced pattern of land and water development and use. Research is needed on the current status and innovations in water law, water use, and transfer arrangements; rural zoning and other land-use regulations; the organization and operation of resource districts and interstate compacts; and property rights in land, including public acquisition of various easements and other property rights.

USDA AND COOPERATIVE PROGRAM

A continuing program of research is conducted which provides inventories and analyses of resource institutions, including innovations that permit more efficient development and use of natural resources. Studies are carried out in four subareas: (A) Water rights and water legislation, (B) land-use regulations, (C) resource districts and organizations, and (D) property rights and impacts of public programs. Much of the research can be characterized as legal-economic utilizing basic information obtained from statutes, constitutional provisions, court decisions, local ordinances, and agency procedures to determine the nature of relevant laws summarize them, and evaluate their economic impact on the use and development of natural resources.

Research is carried out in Washington, D.C., in Berkeley, California and cooperatively at several other locations. These include cooperation with the University of Wisconsin Law School and the Florida and Nebraska Agricultural Experiment Stations, and with the University of Mississippi and Mississippi State University through the Legal Institute for Agricultural and Resource Development of the University of Mississippi. Federal personnel cooperate informally with other agricultural experiment stations and universities, with regional committees, and with other Federal and State agencies. Research was carried out by non-Federal personnel under cooperative arrangements with the Illinois and Arkansas Agricultural Experiment Stations.

A total of 6.0 professional man-years is devoted to this area of research.

PROGRAM OF STATE EXPERIMENT STATIONS

Research in this area is closely integrated with that of ERS and with the respective Law Schools in various States. Through cooperative arrangements, funds are sometimes provided by ERS and sometimes through the Regional Research Program for employing law students to review the laws and relevant court cases.

Most of the research in this area relates to water. The laws in the State are studied to determine the extent and conditions governing property and use rights with respect to water. This will aid later development of a more comprehensive legal and institutional framework for guiding the efficient development and use of water resources. Legal and administrative devices and processes for transferring water between uses and users, the consequences of transfers, and possible modifications which might enhance economic efficiency and equity of water use are being studied in a new regional study in the West.

A total of 6.0 professional man-years is devoted to this area of research.

PROGRESS - USDA AND COOPERATIVE PROGRAM

A. Water Rights and Water Legislation

A comprehensive review and analysis of legal aspects of water rights in the 19 Western States was continued. Slightly more than 80 percent of a two-volume book on a comparative analysis of the water rights laws of the Western States has been completed. Other work which draws upon the Western water law research includes a study of the Utah law of water rights, being published in Utah; a revision, for reissuance of a 1956 California publication, "Irrigation Water Rights in California;" and updating, for reissuance by the University of Idaho Law Review, of "The Idaho Law of Water Rights."

Research on legal aspects of water rights in the East was expanded to include studies of: (1) Water-use regulatory functions of local governmental organizations and ground water law in Florida, and (2) the Mississippi legislation of 1956 concerning the use of surface watercourses, its operation in actual practice, and related laws. A legal-economic analysis of irrigation in Wisconsin will be started soon.

A book on water-use law in Illinois was published. It includes an analysis of Illinois laws dealing with the use of natural watercourses, diffused surface water and ground water. It treats relevant court decisions, statutes, and functions of State agencies and local governmental units. It also discusses relevant federal laws and programs and interstate and international considerations.

A somewhat similar manuscript on water laws in Wisconsin is being revised. This is the first of a series of five publications drawing upon a study of legal and economic aspects of water rights and related laws in Wisconsin, Minnesota, Ohio, and Indiana done under contract by the University of Wisconsin. A manuscript regarding water laws in Minnesota was prepared. One for Ohio is in preparation. An article, based in part on findings of the contract research, was published in Natural Resources Journal.

A manuscript was prepared to supplement a previously published national bibliography on State water-rights laws and related subjects.

Other research includes a study of water laws in Arkansas and an analysis of the development of the riparian doctrine and court definitions of riparian land in various States. This and other research will be used to prepare a manuscript on water rights and related laws in the 31 Eastern States.

During the year, papers concerning water rights and regulation in the Eastern States were presented at several conferences. They included the Water Resources Engineering Conference, sponsored by the American Society of Civil Engineers; the Conference on Water Resources and Economic Development in the South, sponsored by the Southern Land Economic Research Committee; and a seminar sponsored by the Water Resources Study Committee of the University of Maryland. The principal researcher on this project was invited to membership on the Water Resources Committee of the American Bar Association, and to chair a North Central regional subcommittee to review water law research.

B. Land-Use Regulations

Revision of Agricultural Information Bulletin No. 59, "Rural Zoning in the United States," is continuing. A two-part bulletin is being prepared. The first part, for which a draft is nearing completion, discusses rural zoning enabling legislation enacted by legislatures of the 50 States. The second part will be about zoning ordinances and regulations adopted by rural governments and will draw upon tabulations of activities permitted in various zoning districts. The tabulations are keyed to a classification of zoning districts developed for the study.

Study was begun on the relation, and suitability, of flood plain and conservation zoning to the objectives of multiple-use watershed projects.

Interest continues high in zoning as an aid in directing rural-urban land-use transition. Several presentations dealt with this topic. The senior researcher in this area of work prepared two papers for the White House Conference on Natural Beauty and participated in the Conference as a member of a panel on roadside control. A talk on greenbelt zoning

was presented at a seminar of the Northeastern Illinois Metropolitan Area Planning Commission. A paper on zoning in the Western States was prepared for an ERS-BLM seminar. It was reproduced and widely distributed to BLM personnel. It also was reprinted in full in the Public Lands Newsletter, published by the National Association of Counties. An outline on land use planning and zoning was prepared for the Land Use Planning and Zoning Committee of the Soil Conservation Society of America. This outline will be used by the Society in preparing a planning guide.

C. Resource Districts and Organizations

Economic appraisal of local resource organizations was continued. Studies are being conducted to develop techniques for analyzing organizations and to make preliminary applications of the techniques.

A case study of the enabling laws for special districts in Oklahoma is being cleared for publication. The primary emphasis was to develop and test criteria for evaluating the enabling laws. These criteria and their broader application for evaluating special districts' powers were presented before the 1964 meeting of the Soil Conservation Society of America and were published in the Journal of Soil and Water Conservation.

An inventory of special districts in the United States shows that the total number of all special districts more than doubled during the 20-year period from 1942 to 1962. Natural resource special districts more than doubled during the period. While found in every State, they tended to be heavily concentrated in a few. In 1962, five States--Illinois, California, Texas, Oregon, and Washington--contained 40 percent of all natural resource special districts.

Studies of special districts in the Appalachian Region were initiated to determine their potential for aiding in regional development. Review of the enabling laws for resource oriented special districts is underway. Application of factor analysis to the legal summaries of the region as a whole is planned. It will be followed by specific studies in selected areas.

D. Property Rights and Impacts of Public Programs

Analysis of the feasibility of easements and protective covenants for guiding rural land use was discontinued. An article was published in the Journal of Farm Economics and another manuscript is in draft form. The project focused on the feasibility of government purchase of crop restricting easements. The hypothetical program constructed showed that purchase of crop restricting easements might be cheaper than a lease program similar to the Conservation Reserve.

Extensive work by an ERS senior researcher with the U. S. House of Representatives Select Subcommittee on Real Property Acquisition

culminated in publication of Committee Print No. 31. The "Study of Compensation and Assistance for Persons Affected by Real Property Acquisition in Federal and Federally Assisted Programs" is the most comprehensive legal-economic analysis of this subject made. The remedial measures recommended in the report have been embodied in major bills now before the Congress.

Two staff members participated in regional subcommittee work, including presentation of a paper for the North Central Legal-Economic Workshop. One staff member was a consultant to the government of Puerto Rico on rural planning and zoning techniques.

Several staff members in Washington, D. C., reviewed proposed legislation and prepared data for Departmental and interdepartmental use. Examples of the latter include developing procedures for estimating the amount of land involved in urban areas' expansion and classifying legal techniques of possible use in pollution control. Staff members stationed at the Universities of Wisconsin and Mississippi were involved in academic and consultation activities relating to legal-economic and water law research programs.

AREA NO. 3 RESOURCE TENURE INSTITUTIONS

AREA NO. 3.A. LEGAL-ECONOMIC ASPECTS OF LAND AND WATER USE

PUBLICATIONS--USDA AND COOPERATIVE PROGRAMS

A. Water Rights and Water Legislation

Ellis, Harold H. 1965. Water rights and regulation in the Eastern States. Ground Water 3(4) Oct. National Water Well Association.

Hutchins, Wells A. 1964. Ground water legislation. Chapter 17 of Economics and Public Policy in Water Resource Development, Stephen C. Smith and Emery N. Castle, eds. Iowa State Univ. Press.

Mann, Fred A., Ellis, Harold H., and Krausz, N.G.P. 1964. Water use law in Illinois. Ill. Agr. Expt. Sta. Bul. 703. 332 p.

Trelease, Frank J. 1965. Policies for water law: Property rights, economic forces, and public regulation. Natural Resources Jour. 5(1): 1-48.

B. Land-Use Regulations

Solberg, Erling D. 1965. County planning and zoning. Parts I and II. Public Lands Newsletter, Nos. 28 and 29. National Association of Counties.

C. Resource Districts and Organizations

Hanson, Ivan. 1965. Evaluating the role of special districts in natural resources management. Jour. Soil and Water Conservation 20(1): 8-11.

D. Property Rights and Impacts of Public Programs

Griffing, Milton E., and Fischer, Loyd K. 1965. Government purchase of crop limiting easements as a means of reducing production. Jour. Farm Econ. 47(1): 60-73.

AREA NO. 3. RESOURCE TENURE INSTITUTIONS

AREA NO. 3.B. LAND TENURE

Problem. The security, efficiency, and general well-being of rural people and others can be improved through better tenure arrangements. Research of the firm is needed to help develop tenure devices that permit efficient and flexible organization of farms and other rural enterprises. To guide policies and programs, research is needed to determine the effects of economic change among resource owners and resource users and to determine the impact of various public measures on access to resources.

USDA AND COOPERATIVE PROGRAM

The continuing program of land tenure research is carried out in three principal subareas: (A) Basic information on tenure, (B) analysis of tenure arrangements, and (C) analysis of the structure of resource ownership and control. Studies carried out include: Collection and analysis of data on basic changes and trends in land tenure, patterns of landownership, forms of tenancy, and other devices for resource control; legal and economic studies of leasing and other tenure arrangements and their effects on efficiency, scale of operations, investments, and distribution of costs and returns; and effects of changes in conditions under which land is acquired, held, and transferred. Economic implications of land tenure arrangements and the legal and institutional framework within which such arrangements operate are studied.

Cooperative research is carried out in Washington, D. C., and in the following field locations: At Michigan State University, the Agricultural Law Center of the University of Iowa, Iowa State University, and Colorado State University. Work by non-Federal personnel under cooperative arrangements also is done at the University of Cincinnati, Mississippi State University, the University of Tennessee, and Auburn University. The ERS staff also participates actively in regional research committees in the Great Plains, North Central, and Southern States, and in the Interregional Land Tenure Research Committee.

A total of 5.0 professional man-years is devoted to this work.

PROGRAM OF STATE EXPERIMENT STATIONS

Research in this area deals with the problems that young people encounter in getting established in farming, the educational needs of beginning farmers, arrangements older farmers make for intergeneration transfer of the farm, tenure systems best suited to the ever-increasing capital requirements in farming, and the extent prevailing systems of tenure retard or facilitate adjustments to new technology and toward optimum production efficiency.

In the North Central region special attention is given to determining the number of farming opportunities that may become available in some future period like 1980 in relation to the number of young people who may wish to farm. In the same regional project some States are studying land contracts as a means for acquiring a farm with low initial capital. Others are studying corporate ownership as a means of obtaining operating control over land and maintaining ownership continuity over time. This tenure device may minimize the break-up of farms when settling estates. Leasing practices are being studied and suggestions are being developed for improved leasing arrangements.

Studies are also being made of the goals farmers have regarding farm rental or ownership. Practices followed in field leasing for enlarging operations are being studied. This practice is becoming more prevalent.

A total of 11.0 professional man-years is devoted to this area of research.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Basic Information on Tenure

Research on the development and analysis of basic tenure information included a study on landownership patterns and owner characteristics of white and nonwhite landowners in the Southeast. The results were published. Compared to white landowners, nonwhite landowners were older, first acquired land at an older age, had a lower rate of land transfer, relied more heavily upon inheritance as a method of acquisition, and more frequently held land in individual multiple ownership units. These results are based upon the 1960 Southeast Landownership Survey. In the year just completed, a manuscript on rural land ownership and use in Alabama was published and another manuscript, dealing with landownership in Tennessee, was prepared.

Research underway at Mississippi State University involves formulation of a research model to analyze individuals' migration decisions. Personnel

participated in planning task forces at Roswell, New Mexico, and Las Vegas, Nevada, as part of the work being carried out under an agreement with the Bureau of Land Management, U. S. Department of the Interior. Economic base data for the Las Vegas area were summarized for use by the BLM in its planning work.

Work was initiated under a cooperative agreement with the University of Cincinnati Law School to develop a system for collecting, storing, and rapidly recovering land title and land use data. The operational and economic feasibility of applying such a system in a selected area will be examined.

B. Analysis of Tenure Arrangements

Several activities were completed on legal-economic aspects of farm tenure arrangements. A study of installment land contracts in Iowa, previously reported, was published. The report covers both legal and economic aspects of the contracts.

A legal-economic analysis of contract farming was prepared and is to be submitted for publication. The study, carried out under a research contract with the State University of Iowa, examined 420 contract forms and the laws governing such contracts. Contracts were classified in terms of the degree of entrepreneurship transferred. Many of the contracts transferred management control to a contractor without receipt of a commensurate level of responsibility, uncertainty, or other burdens. For example, rather than guaranteeing the farmer a market for his product, many contracts permitted the contractor to refuse to accept the product without any restrictions. Four Farmers' Bulletins are to be prepared as a result of this study. Three will consist of model contracts and explanatory material for production of different commodities. The fourth is to be a more general discussion of contract production, for use by farmers and others concerned with improving contract arrangements.

Participation continued in the North Central regional project on needed adjustments in land tenure to meet changing agricultural conditions (NC-53). Several of the special studies on tenure adjustments should be completed within the next year. A staff member is contributing leadership to and will participate in writing the regional reports.

Research in cooperation with the Iowa Agricultural Law Center included completing a study and preparing a manuscript on operations of the small watershed program in Iowa. Two other projects were initiated. One in cooperation with the Iowa Natural Resources Council will analyze operation of the Iowa water permit system. Another will study the incidence of joint tenancy in selected Iowa counties as determined from recorded land transfers over a 5-year period.

Cooperative research with Iowa State University on farm corporations was completed. Manuscripts are being written.

Formal agreement for cooperative legal-economic research was made with the University of Mississippi and Mississippi State University during the year. The research is to be carried out in the Legal Institute for Agricultural and Resource Development of the University of Mississippi. The research will include economic aspects of land tenure laws, but will not be confined to that area. Some research already initiated is reported under Area No. 3.A., Legal-Economic Aspects of Land and Water Use.

Research on recreational access to public lands was formally initiated under an agreement with the Bureau of Land Management. Study of the legal and related institutional aspects of the access problem has begun.

C. Analysis of Structure of Resource Ownership and Control

Research on land tenure problems and policies of Puerto Rico is nearly complete. A paper on economic growth in Puerto Rico was published in Economic Development and Cultural Change. An analysis was made of the effects of the proportional profit farm system operated by the Land Authority of Puerto Rico. It incorporated an earlier productivity analysis of the farms for the period 1950 - 1961. Various alternative organizations of farm resources were examined in the context of the entire economy. Alternatives included optimizing levels of capital and labor with a fixed supply of land, and disposal of unprofitable units. In every combination studied, the changes would have led to a lower rate of growth for the entire economy. Income losses would have exceeded gains from more efficient farm operation. In addition to goals set forth in law, the proportional profit farm system is being managed to help attain other goals, such as continued economic growth and control of unemployment. Analyses have been completed. Manuscripts are in preparation.

Preliminary research was started in cooperation with Michigan State University, to examine alternative methods of acquiring capital resources needed to establish and operate economically viable farms. The study considers tenure in its broadest sense, i.e., as a set of approaches for owning or controlling all farm resources. Further, it seeks to determine an optimal tenure structure for different farm resources.

Several activities are not specifically identified with subareas of research or line projects. An important, continuing overall activity relates to regional committees. In addition to active participation by personnel as Division representatives on regional committees and sub-committees, various activities sponsored by the committees involved substantial research effort. Two papers were prepared for a Legal-Economic Workshop sponsored by the North Central Land Economics Committee and one

paper on the methods of nonparametric statistics was prepared for a Symposium on Scientific Method and Empirical Techniques sponsored by the Interregional Land Tenure Research Committee. Papers presented at the Conference on Tax Treatment of Exhaustible Resources, and the conference sponsored by the Agricultural Policy Institute, North Carolina State University, and the Southern Land Economics Research Committee were published during the year.

Attention was given also to land tenure reform matters, including consultations with foreign visitors, preparation of materials for two international conferences, and participation in the International Labor Conference. The staff member located at the Iowa Agricultural Law Center, in addition to regional committee activities, was involved in academic and consulting activities associated with the program of legal-economic research.

AREA NO. 3. RESOURCE TENURE INSTITUTIONS

AREA NO. 3.B. LAND TENURE PUBLICATIONS - USDA AND COOPERATIVE PROGRAMS

A. Basic Information on Tenure

Boxley, Robert F., Jr., Gibson, W. L., Jr., and Hoffnar, Bernard R. 1964. The application of probability theory analysis to nonrandom enumeration data. Jour. Farm Econ. 46(4): 835-840.

Boxley, Robert F., Jr. 1965. White and nonwhite owners of rural land in the Southeast. ERS-238. 23 p.

Clonts, Howard A., and Yeager, Joseph M. 1964. Rural land ownership and use in Alabama. Ala. Agr. Expt. Sta. Bul. 356. 35 p.

El Shahat, Mahmoud M. A., and Parcher, L. A. 1964. A tenure size classification of farms. Okla. Current Farm Economics. 37(4): 82-87.

Hill, Howard L. 1965. Agricultural land tenure in the United States. Jour. of the Chartered Land Agent's Society. 64(9).

Wunderlich, Gene. 1965. Taxing and exploiting oil: The Dakota case. Conference on Tax Treatment of Exhaustible Resources, Proceedings. Milwaukee, Wis.

B. Analysis of Tenure Arrangements

Harl, Neil E. 1964. Selected aspects of employee status in small corporations. Kan. Law Rev. 13: 23-58.

Harl, Neil E. 1964. Modifying institutional-legal relations among private parties to facilitate adjustment in agriculture. Jour. Farm Econ. 46(5): 953-961.

Harl, Neil E. and O'Byrne, John C. 1964. Organization and operation of farm and ranch corporations in South Dakota. South Dak. Bar Jour. 33(2): 85-102.

Harl, Neil E. 1965. Public policy aspects of farm incorporation. The Business Lawyer: 933-951, July 1965.

Harris, Marshall D., and Hines, N. William. 1965. Installment land contracts in Iowa. Univ. Iowa Monograph No. 5. 122 p.

Wunderlich, Gene. 1964. Measurement of legal-economic content of vertical integration contracts in agriculture. MULL (Dec.)

Wunderlich, Gene. 1964. Semantic problems of interdisciplinary research. Conference on Optimizing Institutions of Economic Growth, Proceedings, p. 123-134. Sponsored by Agricultural Policy Institute, North Carolina State, and Southern Land Economics Research Committee.

C. Analysis of Structure of Resource Ownership and Control

Stahl, John. 1965. An application of a Klein growth model to Puerto Rico, 1957-1961. Econ. Devel. and Cultural Change. 93(4) Part 1.

Chryst, Walter E., and Hill, Howard L. 1965. Contribution to Obstacles to shifts in the use of land. Documentation in Food and Agriculture, 1965. Series No. 74: 117-140. Organization for Economic Cooperation and Development.

AREA NO. 4. RESOURCE INCOME DISTRIBUTION

Problem. The economic well-being of rural people and others over time is determined by levels and distributions of resource income. Allocation of income to factors of production is affected by functioning of factor markets, tenure institutions and public programs. Changes in land income have major distributional effects in the form of capital gains or losses. Capital gains to one generation of farms become production costs to the next generation. Public programs creating benefits to land also create capital gains to initial landowners and eventually increase capital requirements and production costs to later generations. If this occurs concurrently with a poorly functioning farm labor market, lower income to labor used in farming could result. Changes in incomes to farm families initiated by farm programs changes, technological advance, or other causes may cause income and wealth changes for nonfarm people in local economies. Research is needed on the distribution of resource income, particularly on how it is affected by the interrelationships of public programs, tenure institutions, and technological advance. Research also is needed to understand how people in local nonfarm sectors are affected by public programs directly concerned with agriculture.

USDA AND COOPERATIVE PROGRAM

Studies of effects of natural resource-oriented institutions, policies, and programs upon the distribution of resource income are made. Analyses encompass past, current, and prospective levels of land resource income and relationships of these levels to other factor shares. Emphasis is placed upon determining the role of land institutions and others in distributing gains and losses arising from public programs. The indirect effects of farm programs on local economies also are evaluated. Structural relationships among sectors of agriculturally based local economies and the resource fixities within the sectors are studied. Much of the program is carried out cooperatively with the Agricultural Experiment Stations.

Professional effort currently devoted to the area is at the rate of 6.0 man-years.

PROGRAM OF STATE EXPERIMENT STATIONS

The State stations have no research classified specifically in this area. Projects that contribute to this research are in existence or being initiated by the Experiment Stations of Colorado, Iowa, Virginia, Arkansas, Texas, and Louisiana.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Distribution of Resource Income

Cooperative research on resource returns with the University of Illinois was completed with a manuscript, "Income Distribution on Selected Types of Illinois Farms and Implications for Tenure Adjustments." It shows that the interaction of output increasing technology, inelastic demand for farm products, and fixity of land and operator labor contribute to the dis-association of factor costs and returns. Comparisons between estimated marginal factor shares and corresponding market returns to the factors of production on selected types of farms in Illinois indicate that part of operator's labor and management earings had become embedded in land values by 1959. The increase in land values during the decade from 1949 to 1959 resulted in a decline in the rate of return on current land value of 2.2 percent each five years.

In 1959 the operator's residual market return fell short of the operator's marginal return by $6,200, $2,100, $1,200 and $200 on selected Illinois grain, hog, beef, and dairy farms, respectively. The computation is based on the assumption that the land owners expected a return to real estate that covered the cost of money invested in land, a sinking fund for the purchase of land, a charge for uncertainty of land income, and a manage-ment return on real estate. A technical bulletin is being prepared for publication by the Illinois Agricultural Experiment Station. This re-search project will be terminated during the year, but expansion of the analysis of resource returns will occur in other line projects.

A paper was completed during the year on the relationship of geographical distribution of natural resources, income per capita, and the geographical distribution of farm income. The main hypotheses expressed relationships between initial land resources per capita and current incomes per capita as affected by functioning of the labor market, rates of technological advance, capital accululation, and local economic development. This paper was presented at a workshop on chronically depressed rural areas at Asheville, North Carolina, in April, 1965. It will be published by the Agricultural Policy Institute of North Carolina State University. A paper was presented at the annual meeting of the American Farm Economics Association entitled "Land Values and Land Income: A Paradox?" The main conclusions of the paper were: (1) technological advance, inde-pendently of the income and price support programs, possibly could result in increases in land income and values through increases in marginal value productivity of land (and demand for land) for leaders in adoption while those lagging or failing to adopt the technology also failed to add to the market supply of land; (2) income and price support programs, inde-pendently of technological advance, add to land income and values; (3) the interaction of technological advance and the income and price

support programs has resulted in large increments to farm land values since 1950; and, therefore, (4) the circumstances existing since 1950 were favorable to land value increases without concurrent increases in farm income.

Research was initiated during the year to analyze the trends in land and other resource income by use of statistical models, with the Nation, the States, and a sample of counties in the Central Cornbelt as units for analyses. This work is being carried out cooperatively with Iowa State University. The statistical models for the analysis have been developed, and assembly of secondary data for their implementation is underway. The major objective of this research is to increase our understanding of the reasons for a more rapid increase in land income and values in recent decades than in farm incomes.

B. Incidence of Benefits and Costs of Public Programs

Work by the National Study Group, a subcommittee of the Interregional Land Economics Committee to study the incidence of benefits and costs of public programs, was completed during the year. Six technical papers were submitted for publication. They dealt with public investments in farmland, farm credit programs, technological advance and education, and price supports and acreage allotments.

Cooperation with North Carolina State College continued during the year. Interrelationships of tenure arrangements and public programs affecting trends in resource income distribution for flue-cured tobacco production areas were analyzed. The analysis is completed and publications are in process. The results support two hypotheses: (1) that the price support-acreage allotment programs contributed to a more rapid increase in income to land than to other resources in these areas, and (2) that tenure arrangements permitted landowners to capture most of the benefits of the programs. The annual return to the landlord for his contribution of an acre of tobacco increased from $29 in 1925 to $277 in 1960 for the North Carolina Coastal Plain, and from $14 in 1922 to $212 in 1960 for the Virginia Piedmont. These large increases in land rent are attributable in part to increases in tobacco prices and yields resulting from the price-support and production-control program. The return to tobacco labor increased at only about one-half the rate of the land rent increase over the comparable time period, and the return to capital increased at even a lesser rate. No important changes in crop sharing arrangements were required of landlords to enable them to get this increased return from the program. The value of production items furnished by the landlord increased at a slower rate than did the cost items furnished by croppers and tenants. This particular research project will be terminated during the year and an expansion of this line of work will be included in other projects.

AREA NO. 4. RESOURCE INCOME DISTRIBUTION

PUBLICATIONS - USDA AND COOPERATIVE PROGRAMS

A. Resource Income Distribution

Back, W. B. 1965. Effects of the Natural Resource Base on Chronically Depressed Rural Areas, in Proceedings, Workshop on Problems of Chronically Depressed Rural Areas, Agricultural Policy Institute, North Carolina State. 16 p. (In press)

Back, W. B., Editorial Services, Regional Development Analysis, Agric. Policy Institute, N. C. State, 1965.

Chryst, Walter E., 1965.Land Values and Agricultural Income: A Paradox? Proceedings, Journal of Farm Economics.

Strohbehn, Roger W. Resource Productivity and Income Distribution with Implications for Tenure Arrangements. Illinois Agricultural Experiment Station Tech. Bul.___.

B. Incidence of Benefits and Costs of Public Programs

Chryst, Walter E. et.al. (Eds.). 1965 Selected Papers on Incidences of Benefits and Costs of Public Programs Affecting Agriculture. USDA Misc. Pub.___. 112 p.

AREA NO. 5. IMPACTS OF URBAN GROWTH ON RURAL AREAS

Problem. Demands for land to be used for nonfarm purposes is increasing. At the same time, demand for land used in agricultural production is decreasing. These conflicting trends cause many conflicts of interest. Often uneconomic developments result. Research is needed to guide adjustments in land use for an orderly and economic transfer from agricultural to nonagricultural uses. Such research will develop alternative ways of preventing or minimizing the deleterious effects of urban growth on rural economies.

USDA AND COOPERATIVE PROGRAM

Research on urban impacts is divided into two subareas: Studies under subarea (A) land use changes on the rural urban fringe are made to show the results of rapid urbanization on nonagricultural demand for land, ways to reduce the impact on agricultural activities, and to project the effects of future demands on the land resources. Studies under subarea (B) outdoor recreation are made to determine characteristics of recreation enterprises, influences of demand, area and kinds of land needed for various types of recreation, and factors involved in public or private ownership and management of land for recreation.

Information is drawn from several disciplines in addition to economics. Formal research cooperation under a memorandum of understanding was begun with the University of Maryland and under a cooperative agreement with the University of Michigan during the year. Informal cooperation on an open space study for the National Capital Region was maintained with Virginia Polytechnic Institute. Informal cooperation also is maintained with many governmental agencies, State experiment stations, and other organizations.

Approximately 1.6 professional man-years were devoted to the program on the urban impacts on land use, including 0.3 man-years of program leadership--much of which involved special assignments. By subareas of investigation, personnel were committed as follows: land-use adjustments on the rural-urban fringe, 0.6 man-years, and outdoor recreation, 0.7 man-years.

PROGRAM OF STATE EXPERIMENT STATIONS

The State stations only recently have given much emphasis to land problems near urban areas or resulting from the encroachment of the suburbs into rural areas. Studies underway deal with the extent to which urban influences cause land prices to rise above agricultural values and the rate at which urban land uses move into the country.

Other studies analyze the use which rural residents make of open land and how the concept of part-time farming may satisfy the need for open space. The effect of highway improvement on land use and community development is also being studied. Increased attention is being given to principles and practices for guiding the orderly development of areas affected by industrial, residential, and recreational influences.

Total professional man-years involved is 2.0.

PROGRESS--USDA AND COOPERATIVE PROGRAMS

A. Land-Use Adjustments on the Rural-Urban Fringe

A study of ways to maintain agriculture in the rural fringes of the Washington, D. C., metropolitan area, formerly proposed by the Joint Open-Space Project Committee of the National Capital Regional Planning Council, was begun by economists at Virginia Polytechnic Institute in cooperation with the Northern Virginia Regional Planning and Economic Development Commission. The Urban Impacts Investigation has provided technical assistance on the study. More than 100 annotated references were prepared to provide background information for the VPI study. A manuscript relating the California experience in preserving open spaces around its cities with the possibilities in the National Capital Region was completed.

The California experience provides little encouragement for holding substantial tracts of open space in metropolitan areas in farming or other extensive uses under private ownership. The "agricultural cities" in Los Angeles and Orange counties have been dissolved. Greenbelts and other zones that restrict land to agricultural uses only slow down the urbanization of former farmland. Greenhouse (flower) operations, a small acreage of irrigated strawberries, and a small area of cherry orchards currently are the only farm enterprises able to pay returns on investment comparable to residential development. Other kinds of orchards and truck crops cannot compete.

A few industrial developers and some residential subdividers acquired lands in excess of current needs. Orchards and other agricultural uses frequently are being maintained as open space on these holdings until the land is needed for more intensive development. Experience with new towns, condominiums, and other modern urban design ideas appear to hold hope for keeping some land in open uses in a quasi-private status (ownership in common or restricted deed). State and county land-managing agencies often consider buying development rights and easements, but most of them prefer to acquire full fee title to land. Parks, parkways, and natural areas, in addition to highways, are being emphasized in present public acquisitions of open lands. The term "greenbelts" is commonly used in California to describe desired pieces of open land in metropolitan areas. It

frequently connotes land to be maintained in agriculture but also applies to parks, parkways, and other kinds of public land use areas.

A paper, "Land--An Elusive Variable in Regional Planning," was prepared for publication by the Soil Conservation Society of America. This paper discussed some economic factors which help explain the urban fringe land market phenomenon to people unfamiliar with this situation.

Cooperative research with Delaware was essentially completed with publication of a journal article and completion of Extension Bulletin 88 of the University of Delaware Extension Service entitled "Suburban Development in Metropolitan Northern Delaware."

B. Outdoor Recreation

Personnel of ERS served on a Task Force that prepared a special "report of the Secretary of Agriculture on USDA plans to implement the objectives of the Natural Beauty Program." This report and other contributions from ERS personnel provided background for the White House Conference on Natural Beauty. An ERS staff member serves as a member of the executive committee of the USDA Working Party on Outdoor Recreation. This committee acts as a Department policy staff on outdoor recreation. A feasibility study of commercial shooting preserves in Maryland was begun in June, 1965. Preliminary results show that Maryland shooting preserves are operated by two classes of operators: (1) those with substantial outside incomes (whose preserves generally show losses) and (2) those whose major income is from the preserve. Most of the preserves apparently are unprofitable. Better business management of the shooting preserve enterprise is needed before the industry can show solid profits.

Support is being provided to Dr. John Fraser Hart, University of Indiana, for preparing a paper about land abandonment in Appalachia and its fringes. Professor Hart will describe and analyze the geographical pattern of cropland abandonment since about 1910, examine the reasons for this abandonment, and discuss alternative land uses that can and should be developed for future utilization of these land resources. He will emphasize the region's capabilities for meeting outdoor recreation needed by growing Eastern populations and evaluate income possibilities for the local people.

A study of the factors affecting the economic use of land, water, and related resources in parts of the Northern Lake States Region has been undertaken in cooperation with the University of Michigan under a cooperative agreement. This study will evaluate opportunities for developing recreational uses under private, public and combinations of resource management arrangement. Since this work is only begun, no results or observation are available.

A study of rural recreation developments in Appalachia was planned. It will involve cooperation with the Bureau of the Census for tabulations of statistics and analysis of farms reporting recreation business and recreation income in their 1964 returns. Recreation data will be related to farm and operator characteristics and evaluated. A sample from the list of farms will be drawn for a mail survey to be followed by interviews in depth on a selected sample of cases to provide information on investments, net income, expenses, labor requirements, potentials, and problems. This project will require approximately 3 years for completion.

AREA NO. 5. IMPACTS OF URBAN GROWTH ON RURAL AREAS

PUBLICATIONS--USDA AND COOPERATIVE PROGRAMS

A. Land-Use Adjustments on the Rural-Urban Fringe

Vaughn, Gerald F. 1964. In Search of Standards for Preserving Open Space. Pub. Admin. Rev., Vol. XXIV, No. 4, Dec. pp. 254-258.

Crosswhite, Wm. M. and Vaughn, Gerald F. 1965. Suburban Development in Metropolitan Northern Delaware. Ext. Bul. 88, Univ. of Del.

AREA NO. 9. ECONOMIC FRAMEWORK AND CRITERIA FOR RIVER BASIN AND WATERSHED DEVELOPMENT

Problem. Development of comprehensive plans for all major river basins was recommended by the Senate Select Committee on National Water Resources in its report of January 1961. This recommendation is being carried out through a cooperative inter-Departmental program of surveys conducted under the auspices of the Federal Water Resources Council. Formulation of these plans requires an adequate framework of economic data, projections, and systems of analysis. It also requires uniform application of appropriate evaluation standards and concepts. Economically sound comprehensive river basin plans are needed because (1) large capital investments are being made by public agencies in water resource projects, (2) an expanding economy is pressing on available resources, (3) underemployment of resources exists, (4) production and income stabilization is needed, and (5) technology is advancing.

Economic research is needed to identify potentials for developing major water resource regions and to equate their relative economic efficiencies to emerging national and regional requirements and objectives. Continuous reappraisals are required to relate changes to potential supply of and demand for natural resources in the development potentials of the various regions.

USDA AND COOPERATIVE PROGRAM

Current activities are concerned with the following areas: (1) development of standards and practices for economic evaluation and program formulation; (2) national and interregional analysis and projections of economic activity and resource use in the agricultural and rural sector; and (3) regional economic base studies involving appraisals and projections of economic activity in rural areas. These studies provide a framework for economic evaluations of needed agricultural and other rural developments and for appraisal of alternative patterns and schedules of development. Although basic research is undertaken, emphasis is on applied research. This research is carried out in 26 field locations and in Washington, D. C. Regional headquarters are maintained at Little Rock, Arkansas; Stillwater, Oklahoma; East Lansing, Michigan; Upper Darby, Pennsylvania; and Logan, Utah.

The investigational activities are carried out under provisions of a memorandum of understanding among the Soil Conservation Service, Forest Service, and Economic Research Service, and through cooperative agreements with the Corps of Engineers, Public Health Service, and other public agencies.

A total of 18 professional man-years is devoted to the overall investigation.

PROGRAM OF STATE EXPERIMENT STATIONS

Research in this area is primarily that of establishing benchmarks from which to measure progress resulting from the small watershed programs. Resource development situations are carefully recorded and analyzed. At periodic future dates the areas will be studied again to assess the effects of certain basic programs. Significant items used are progress in converting land from intensive to extensive use or vice versa, change caused by flood reduction, trends in real estate prices, and the value of recreational development.

A total of 4.3 professional man-years was devoted to this area of research.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. General Standards and Practices for Economic Evaluation and Program Formulation

Work continued on developing improved evaluation standards for water resource programs through participation on interdepartmental task groups. Activities of such groups resulted in a report on "Price Standards for Planning and Evaluating Water and Related Land Resources." The report was designed to establish a consistent set of interim normalized prices for use in evaluating the economic effects of water resource projects and programs, pending development of mutually acceptable long-term price projections.

B. National Interregional Analyses and Projections of Economic Activity and Resource Use in its Agricultural and Rural Sectors

Branch personnel continue cooperation with the Office of Business Economics, Department of Commerce, in a program of economic and statistical analyses and projections for comprehensive river basin studies.

The project involves a careful examination of major factors that will shape future changes in the geographic distribution of agricultural output and employment. They include: (1) Agricultural production and marketing technology, their differential effects between regions and subsectors of the agricultural economy, and their impact on the structure of related economies; (2) regional differences in availability, quality, and productivity of the natural resource base and relative potentials for increased output in terms of production cost differentials; (3) transport cost factors relative to future centers of consumption, as indicated by

the population projections of OBE; (4) prospective depletion of natural resources available for agricultural use resulting from factors such as depletion of ground water, deterioration of soil resources, and encroachment by nonagricultural developments; and (5) institutional and other factors that influence the location of economic activity, such as public programs designed to influence agricultural output and land use.

Progress continues on establishment of an agricultural data bank to provide for the tabulation, analysis, and updating of currently available data relating to agriculture, land use, and rural economies for all counties of the Nation. When completed it will include rapidly retrievable statistical information useful for framework studies, and for detailed planning studies of subbasins.

Development of a set of realistic economic projections for the 16 regions requires a system of analysis which can simultaneously consider many alternative and interrelated factors. A linear programming model has been selected as a method for evaluating alternative means of meeting projected national food and fiber requirements. This national interregional model will be used to project the geographic distribution of output, land use, and employment of economic resources for given levels and composition of national product requirements. The system can make projections under a variety of assumptions regarding supplies of natural resources as might be influenced by water development programs.

Procedures for obtaining current cropping patterns, crop production data, and potential development for soil resource groups were developed in cooperation with the Soil Conservation Service. An automatic data processing system is being prepared to summarize this major land use and production data for some 15 soil resource groups within each of the approximately 150 land resource areas.

A computer program has been developed which will sort data from designated counties into economic subareas, river basins, land resource areas, or other categories and produce tabulations of selected agricultural production data from the Censuses of Agriculture for 1949, 1954, 1959, and 1964.

Preliminary projections of agricultural output have been made for 16 water resource regions based upon such factors as historical contribution of regions to the U. S. total, and losses or gains in the resource base of the regions. Simultaneous regional allocations of national food and fiber requirements establish estimates of regional agricultural output consistent with national needs. This set of national-regional economic projections is being used in framework studies of the Ohio, Upper Mississippi and Missouri River Basins.

C. Analysis and Projection of Regional Economic Activity

Widespread water shortages in recent years, some of them quite dramatic, have focused public attention on water problems. These shortages emphasize the need for framework studies. Each framework study includes inventory analysis and projection of economic activity in the study region.

At the present time, economic investigations of the framework type are underway in the Ohio, Upper Mississippi, Missouri, New England, Susquehanna-Chesapeake, and Colorado River Basins. A seventh framework study, the Columbia-North Pacific Basins, was initiated late in the reporting year. Additional comprehensive framework studies, completing coverage of the contiguous 48 States,will be done when funds become available. Comprehensive framework studies are also proposed for Alaska, Hawaii, Puerto Rico, and the Virgin Islands.

The Ohio River Basin Study is well advanced. A preliminary report on the present agricultural economy indicates that there are 94.3 million acres in private ownership in the basin. Slightly over half of this is in cropland and pasture that is considered suitable for agricultural production. By the year 2010, 2.7 million acres of existing pasture and cropland is expected to be used for urban, industrial, and other nonagricultural use.

Projections of national food and fiber requirements were completed during the year. A share of these requirements was allocated to the Ohio region, based on historical production patterns. Estimates of changes in the productive capacity of the land resource and feeding efficiencies for livestock were developed in cooperation with the Ohio Agricultural Experiment Station. These data have been utilized in a projection model to estimate the likely use of the land resources for agricultural purposes. Preliminary results indicate that nearly 13 million acres presently used for cropland and pasture would not be used for agricultural production by 1980. However, expected population increases, expected changes in per capita consumption rates of agricultural products, and the expected adoption of crop and livestock production technology indicate that nearly all of the unused land resource would be utilized for agricultural production by 2010.

Analysis of the irrigation and drainage potential on agricultural lands in the Ohio River Basin was continued. A report summarizing the Basin projections and projection methodology is in process at the present time.

Considerable progress was made on the Upper Mississippi River Basin Study. In October 1964, a preliminary report concerning the present agricultural

economy of the Basin and subbasins was issued. The report indicates that the Basin contains 120.9 million acres of farmland, accounting for a large proportion of both the Corn Belt and Lake States dairy region. The Basin includes about one-sixth of the Nation's farms. Nearly one-fourth of the U. S. livestock, milk, and feed grain production comes from Basin lands. Some half million farm operators have an investment in land and buildings, averaging $230 per acre, which when added to livestock and machinery investments represent a significant part of the total Basin economy.

An analysis of future cropping patterns is underway. Preliminary projections indicate that crop yields will increase as much as 30 percent by 1980 and some average yields are expected to double by 2020. These estimates for some 3,000 soils are being reviewed by Agricultural Experiment Station personnel throughout the Basin. Estimates of changes in aggregate feeding efficiencies are also being developed and reviewed by the Experiment Stations.

A study of the agricultural land drainage potential on a Land Resource Area basis has been completed for Minnesota and Wisconsin. Other Upper Mississippi state drainage studies are in process. A study to develop production costs for the crop possibilities by soil groups in the Basin has been initiated. An urban impact analysis was commenced late in the reporting year.

ERS is cooperating in all phases of the framework study for the Missouri River Basin. Particular emphasis is on participation in two agricultural task forces relating an economic base study and problems of evaluating land and water needs. Time schedules were developed for task force participation; a generalized program of work embracing essential agricultural activity was completed; and a statement of criteria, methodology, and procedure for the Agricultural Task Forces was prepared. In addition, a generalized methodology for disaggregation of regional projections of needs for agricultural products in the target years, 1980, 2000, and 2020 was developed.

Soil resource groups, delineating soil capabilities and limitations, were developed jointly with the Soil Conservation Service for all land resource areas in the Basin. Procedures for obtaining current cropping patterns and crop production data for these soil resource groups were also developed. This included an automatic data processing system to summarize major land use data by soil resource groups and land resource areas from the 1958 Conservation Needs Inventory. The system also creates working forms for recording intermediate estimates. It also edits input data and inserts codes on the basic automatic records to enable subsequent summarization by subregions, subareas, and subbasins appropriate to the Missouri Basin Study. A study of developing cropping patterns and present crop production data was completed through the preliminary estimates stage in South Dakota. A similar study was initiated in Colorado.

The economic base study for agriculture in New England is continuing. Further refinements will be made of agricultural production, employment, and rural water requirements for 18 sub-State areas. In Maine, the production of cattle and calves, broilers, and vegetables is expected to shift slightly towards Aroostock and Penobscot counties; New Hampshire is expected to experience some shifting of poultry, vegetable, and apple production to southern and coastal regions; agricultural production for Vermont is expected to concentrate in the western half of the State; and Massachusetts, Connecticut, and Rhode Island are expected to show a declining agriculture as the result of urban expansion, with that which remains being concentrated largely in the Connecticut River Valley. Cranberry production in Massachusetts is an exception to this generalization.

The Susquehanna-Chesapeake Bay drainage area economic base study for agriculture is continuing. Major efforts are centered in making projections of rural farm and nonfarm populations, agricultural employment, agricultural income, and number and size of farms. Projections have also been made under contract to ERS by the Pennsylvania State University for expected future crop yields and fertilizer use. Generally yields in the Northeast, varying by crop and location, are expected to increase from 8 to 25 percent by 1970, 18 to 56 percent by 1985, and 40 to 150 percent by 2020.

Considerable progress was made in two subbasin analyses conducted within the framework of the overall economic base study of the Colorado River Basin. Major accomplishments within the Upper Main Stem Subbasin are reflected in development of agriculture and forestry sectors for an input-output or interindustry study. Preliminary studies suggest that a dollar change in final demand (mainly export) for the agricultural and forestry sectors, approximately $1.30 total sales is generated in local sectors of the economy. Magnitudes for nonagricultural sectors of the Basin economy are similar to those for agriculture. Projections of future output and final demand for agriculture and forestry have also been made. An interindustry input-output table for a base year, 1960, was completed for 6 agricultural sectors and the forestry sector of the economy of the San Juan Subbasin. Projections of agricultural and forestry activity in the subbasin for 1980 and 2010 were made. These estimates were analyzed within the water quantity framework of the Colorado River Compacts and the water quality constraints existing in 1960. Additional quantity and quality constraints will be introduced into the model as the work progresses.

Finally, the most recent framework study to be undertaken, the Columbia-North Pacific Basin, was initiated on July 1, 1965. This study is still in a very preliminary stage of implementation and professional staffing.

AREA NO. 10. RIVER BASIN DEVELOPMENT INVESTIGATIONS

Problem. Emerging problems and conditions in vast areas of the country are causing concern about the management and development of water and related land resources. Among these conditions are: (1) critical water shortages causing distress in both rural and urban areas; (2) rapid deterioration of water quality in many streams and bodies of water; (3) increasing demands for water, resulting from rapid increases in population and growth of water-using industries; (4) depletion of high-quality water-storage sites; and (5) economic development in areas suitable for water storage.

Unprecedented interest and activity in comprehensive river basin planning have resulted. These planning efforts promise several benefits and advantages compared with the traditional, single-purpose, piecemeal approach. Included are the following: (1) more advantageous allocation of water between competitive uses; (2) improved coordination between the developments of Federal and State agencies; (3) more effective consideration of alternative developments; and (4) more adequate consideration of sources of desired products and services other than water development.

USDA AND COOPERATIVE PROGRAM

Current investigations concern development and refinement of improved methods for river systems planning; participation in plan formulation for river basins and subbasins, including investigations to identify and evaluate economic needs for development in rural areas, and analyses of benefits and costs of development alternatives; and economic review of Federal agency reports on proposed water resource developments. Most of the studies are applied economic research. Research at field locations is cooperative with the Soil Conservation Service and the Forest Service. Cooperative investigations of specific water resource development proposals and problems are also undertaken with State water resource agencies, the Corps of Engineers, the Public Health Service, and other public agencies.

Major elements of ERS participation in the interagency program include: (1) analysis and projection of (a) economic activity in the agricultural and related sectors of the economy, (b) other economic activity in rural areas, and (c) the demand for land and water resources; (2) assessment of current and projected demands for goods and services obtainable from using water and related land resources and translation of such demands into economic needs for development; (3) analysis of agricultural and rural water problems relating to economic activity in rural areas; (4) economic appraisal of agricultural and rural needs for water and related land resource development; (5) appraisal of prospective economic impact

of development alternatives on the agricultural, rural, and related sectors of the economy and the economic relationship of these alternatives to the coordinated and comprehensive development of the basin; and (6) consulting services to Soil Conservation Service and Forest Service, in developing and applying standards and procedures for assessing the economic feasibility of watershed developments.

Approximately 22 professional man-years are currently devoted to the overall research program.

PROGRAM OF STATE EXPERIMENT STATIONS

The State stations have no research classified specifically in this area.

PROGRESS-USDA AND COOPERATIVE PROGRAMS

A. Methods and Techniques of Analysis for River Systems Planning

Comprehensive river basin planning is currently handicapped by inadequate systems of economic analysis or the total absence of needed planning methodology. Potential gains from comprehensive river basin planning are directly related to the extent to which the demand for improved systems of analysis is satisfied.

Investigational efforts to improve the analytical techniques of river systems planning were undertaken or extended during the year. The extension and adaptation of the "minimum cost linear programming technique" received attention--both as a technique for interregional and subregional projections and as a method for evaluating long-range economic impacts of development alternatives. A successful injection of "transport costs" into the system in a study of the drainage areas of the Chesapeake Bay is of special interest. It permits specific orientation to centers of consumption.

Development of techniques for translating output and land use results from the linear programming system into on-farm employment and income is underway. Measures of economic activity in locationally related industries of the trade ,service and processing types also are being considered.

A third example of improved basic methodology for river basin planning was development of a "gravity model" and computer program for estimating geographic use-patterns for recreation facilities under a range of conditions. This method provides a systematic and consistent means of estimating recreation needs when population, income, and extent of water development are given.

Developmental work was also carried out on the use of soil survey data, weather records, and farm survey techniques as a means of evaluating the economic losses from drought. The effect of drought susceptibility on area economic activity is being examined. Limited work is also being placed on an analysis of the effects of flooding.

New analysis techniques leading to improved river basin planning examined included appraisal of input-output, programming, and simulation models for possible integration modification, and application to basin planning problems. The goal of this activity is a complete analytical system for the economic appraisal of needs for water resource development.

B. Participation in Comprehensive River Basin Surveys

Where framework studies are primarily concerned with hydrologic and economic relationships among broad water regions, planning for water resources development within basins and subbasins involves two major problems: (1) deciding where additional resources can be most economically employed and (2) in what amounts, consistent with immediate and short-term water needs.

Preliminary economic projections for the Wabash River Basin were completed. These projections indicated that more than 300,000 acres of land in the Wabash River Basin will be required for expansion of urban and built-up uses by 1980. No shortage of land for agricultural production was indicated. Expected yield increases in major crops will enable Basin farmers to meet demands for food and fiber and still have about 2 million acres of idle land in 1980. Corn, the major feed grain crop, is expected to average some 25 to 30 bushels per acre above current yields, due to technological advancements and concentration of production on the more fertile soils.

A preliminary report on irrigation in areas affected by 5 reservoirs proposed by the Corps of Engineers was prepared. Actual acreage irrigated was only about 1 percent of the amount on which irrigation was physically feasible. Estimates of aggregate irrigation benefits based on the Ohio Basin drought study are being prepared.

The Grand River study, a comprehensive interagency undertaking, will identify specific water resource development measures. It is concentrating on projecting future cropping patterns, rural farm population, and farm labor requirements. Throughout the projection period to the year 2020, sufficient cropland is expected to be available for agricultural use, even with levels of feed grain exports from the area at 40 percent above Basin livestock feed requirements. Crop yields were projected to approximately double, from current levels, rural farm population is expected to decline by two-thirds, and farm employment is expected to decrease by about one-third by the year 2010.

Preliminary projections of agriculture in the Willamette River Basin were made for 1980. They indicate increasing specialization in fruits, vegetables, beef, and broilers, with little change in cropland. A statistical analysis of past irrigation in the Basin and three subareas was made and some tentative estimates of future irrigation prepared. The study indicated about 9 percent more irrigated acres annually from 1939 to 1959, while estimates for 1980 suggest a 2 to 4 percent increase per year. About 500,000 more urban residents could settle on the present urban area, assuming a population density similar to that of Portland.

Studies in progress in the Genesee River Basin indicate that livestock production is expected to more than triple by 2020 and crop production to more than double. Most of the expected livestock product increase is in milk production. The crops are either vegetables or feed crops supporting the dairy industry. Most crop yields are expected to increase by about 210 to 230 percent so that land requirements to meet this output show a small but gradual decline from present levels.

Agricultural labor requirements in the Genesee River Basin are expected to gradually increase from 20,700 to 29,000 by the year 2020, when expressed as man-year equivalents. These projections include an allowance for shorter working hours and longer vacations, but no allowance for part-time workers.

In 1959, nearly 5,000 acres were irrigated in the area adjacent to the Barge Canal. It is estimated that an additional 13,000 acres of vegetables are of the kinds expected to be irrigated by 2020.

In the Puget Sound Basins, accomplishments in the past year include compilation and analysis of secondary economic data to provide information to cooperating agencies, and aggregation of basic data concerning soils in the Puget Sound region. Analysis of data on farm drainage systems indicates that approximately 50 percent of the State activity in this program is in the 12 counties of the Puget Sound region.

Efforts to identify specific water resource developments in the Big Muddy Basin continue. A report, based largely on data from the Census of Agriculture and the Illinois Cooperative Crop Reporting Service, was completed. Farms in the Basin are 17 percent smaller than the average for the State and gross sales per acre of farmland are only about half as great. Preliminary projections of agricultural activity to 1970 and 1980 were completed. Some adjustment may be required following completion of the economic base study of the Upper Mississippi Basin, of which the Big Muddy is a subbasin.

An inventory of secondary data was completed in connection with the Red River Basin study. Current land use data were also developed by States,

county, and land resource area. They were also projected for 1980 and 2015, based upon national-regional relationships and State-Basin area relationships. Resource use and needs data for diverse purposes are being developed by work groups established by the Interagency Coordinating Committees.

Much progress was made in advancement of studies in the Big Black, Pearl, and Pascagoula River Basins. Work completed included (1) identification of agricultural activities and resource use; (2) completion of inventories of the areal extent of flood water, drainage, and irrigation problems in agriculture; (3) projected use of resources by agriculture for the target years 1980 and 2015; (4) identification of the relative agricultural production efficiency of different land resources; and (5) the initiation of analyses to identify potential benefits to agriculture from alleviation of floodwater, drainage, and irrigation problems.

A study of the Upper Columbia River Basin was undertaken and completed in connection with a proposed Federal navigation project. It was concerned primarily with developing estimates of projected production, processing, and availability for export of several agricultural products that might be transported by water from a 10-county area. According to the study, estimated harvested cropland could increase from 2,065,000 acres to 4,429,000 acres by 2010. Where irrigated cropland accounted for 632,000 acres in 1959, it could rise to 1,115,000 acres in 2010. In this same period, wheat production was estimated to double, sugar beet production to increase about 1.5 times, all vegetable production, including potatoes, about 4 times, and all fruit, mainly apples, to about double.

Under contract with the New York Department of Conservation, Division of Water Resources, the Erie-Niagara Basin study is moving forward. While the rural farm population has been decreasing steadily and this trend is expected to continue, total rural population has increased steadily in nearly all portions of the Basin. Value of agricultural sales is expected to increase from 126 million dollars in 1960 to 312 million dollars in 2020 for the 8-county economic area. Farm employment is expected to decline until about 1990 and then gradually rise as production needs increase faster than labor efficiency. While nearly 4,300 acres were irrigated in 1960, about 38,000 acres of vegetables are of kinds expected to be irrigated by 2020.

Studies were completed for the Florida West Coast Tributaries survey. Accomplishments on this project include (1) the integration of land use projections based on special economic studies and results of opinion surveys of area technicians; (2) selection and presentation of relevant major components of the national economic framework including projections to 2020; (3) development of detailed national and Basin

economic guidelines and assumptions; (4) an analysis and description of the total economy of the Basin in sufficient detail to provide perspective for more comprehensive treatment of the agricultural industry; (5) estimation of values for major inputs and outputs for the major agricultural enterprises and groups of minor enterprises with agribusiness values as measurements of indicated resource development; and (6) evaluation of impacts which may be derived from future resource developments as they relate to agriculture.

Projections were made of agricultural population, employment, and income for the Sabine River Basin for 1980, 2000, and 2020. Additionally, current normal production was determined and projections made of requirements for major farm products from the Basin for these periods. The indicators of economic activity and growth will be used in determining needs for water and related land resources and provide the basis for a coordinated plan for resource development.

Normalized yields, fertilizer inputs, and cropping patterns by land capability units and land resource areas were completed, reproduced, and distributed for the Elkhorn, Big Blue, and Little Blue River Basins. This information is presently being used by cooperating agencies in the analysis of flood, drainage, and erosion damage. Projections of economic activity and resource use, as a basis for evaluating future resource development needs, were also made for the years 1980, 2000, and 2020.

A draft report analyzing the present economy and future economic activities of the James River Basin was prepared. The land base was classified into 13 evaluation soil groups. A cropping pattern for each group was determined. Current normalized and projected yields determined for each soil group also were used to estimate the possible production level of the basin in 1980 and 2020 without resource development.

Activities and accomplishments on the Arkansas River Multiple Purpose Project are progressing in two phases. The first phase included summarizing and analyzing data on organization, management practices, and yields for 1964 for three areas--Fourche Island, Hartman Bottoms, and McLean Bottoms. These areas are typical of the alluvial land that might be adversely affected by increased navigation stages. A summary report was prepared for calendar year 1964 and presented to the Corps of Engineers Regional Office at Dallas. It included evaluations of the physical, hydrologic, and economic conditions in the three study areas.

For the second or projectional phase, a report of agricultural use of land resources in Arkansas was completed. Production budgets for land resource areas and soil groups were prepared for major crops; and a tentative detailed outline was developed for identifying primary and secondary impacts on agriculture which will result from the proposed navigation project.

Progress on the Sevier River Basin included collection of secondary statistical data; completion of a detailed survey of 317--or 10 percent--of the farmers in the Basin; and analysis useful to agencies concerned with resource planning and development in the area.

A methodology for evaluating recreation benefits of planned reservoirs in the Meramec River Basin was developed in cooperation with the University of Missouri. Cooperation also was maintained with personnel of the Clark National Forest in developing recreation data for proposed developments. Projections of crop and livestock production for 1980 and 2010 were prepared. Research personnel also cooperated with the Soil Conservation Service in quantifying potential acreages of crops and identification of maximum rotations and crop yields by soil groups.

Studies similar in scope and intensity to those above-mentioned are also being conducted in the Upper Rio Grande Basin, the Central Lahontan and Humboldt River Basins in Nevada, the Kanawha River Basin in West Virginia, the Poteau River Basin in Arkansas, the St. Joseph River Basin in Michigan, and the North Coastal Basins of California.

Although compelling land and water problems are pervasive in all of these basins and subbasins, these vary by type, magnitude, and effect upon economic activities and resource use. For all these continuing studies, data collection, analyses, and projections of land and water needs are in various stages of completion. Preliminary reports have been issued in some instances.

C. Economic Review of Federal Agency Reports on Water Resource Development Projects

Public works for resource development constitute one of the major items in the Federal budget. These include facilities for regulation and distribution of agricultural, industrial, and municipal water supplies; improvement of rivers, lakes, and harbors for navigation and recreation; multiple-purpose development of river basins; flow regulation for pollution abatement and for enhancement of fish and wildlife habitat; and facilities for generation and transmission of hydroelectric power. Proposed projects thus embrace many problems in managing land and water resources--including drainage, erosion control, and optimum land use. Consequently, proposed plans and projects are subject to critical review for conformity to accepted economic standards and compatibility with national resource goals and policies. The required economic review and evaluation of other Federal agency resource development project proposals is a continuing ERS responsibility.

During the year, 40 projects of the Corps of Engineers, 15 projects of the Bureau of Reclamation, and a special project submitted by the State of Hawaii, were subject to critical review and analysis. For each

project evaluated, general and specific economic comments were prepared as an integral element in the Departmental review process.

AREA NO. 11. WATERSHED PROGRAM ANALYSIS

Problem. Under provisions of the Watershed Protection and Flood Prevention Act (PL 566), ERS provides technical and financial assistance to local watershed groups. The groups must be willing to assume responsibility for initiating, carrying out, and sharing costs of upstream watershed conservation practices providing flood control and water management for agricultural and nonagricultural purposes.

Watershed activities will be an integral part of National resource programs for many years to come. The National Inventory of Soil and Water Conservation Needs, completed in 1961, disclosed a need for project-type action by public agencies on more than 8,000 small watersheds. This was 65 percent of those delineated. These watersheds encompass some 1 billion acres, or about 55 percent of the national land area exclusive of Alaska. An estimated 61 million acres need project action for flood protection, 15 million acres need irrigation, and 43 million acres need drainage.

Analyses of planning and economic evaluation needs to support locally initiated and locally sponsored Resource Conservation and Development Projects were authorized by the Food and Agriculture Act of 1962. Analyses of installed facilities will be concerned with changes in resource use, production efficiencies, employment, and income. The feedback from such evaluations will enable the refinement of planning methodology applied to subsequent projects.

USDA AND COOPERATIVE PROGRAM

The program of basic and applied research is divided into two major subareas: (1) Economic and related institutional aspects of watershed planning, development, and management, and (2) development and improvement of economic methods and techniques in support of locally coordinated resource development project planning. The program emphasizes cooperation with the Soil Conservation Service, Forest Service, and various State Experiment Stations.

Major elements in the research program include inventory and economic analysis of watershed work plans; appraisal of economic and institutional impacts of installed watershed projects; pilot watersheds and Washita River Basin; development of methodology and techniques for selected economic evaluations; secondary impacts of watershed resource development projects on the local, regional, and national economies; and development of planning criteria, economic standards, and analytical methodology for RC&D projects.

Program activities under PL 566 are undertaken in Washington, D. C., and in field locations at Little Rock, Arkansas; Denver, Colorado; Stillwater,

Oklahoma; and University Park, Pennsylvania. In Oklahoma and Pennsylvania, the research is conducted in cooperation with the respective State Experiment Stations. The program of work is provided for by a Memorandum of Agreement with the Soil Conservation Service, executed in 1955, and its composition is designed by means of annual work plans prepared cooperatively by the two Services.

A Memorandum of Understanding with the Soil Conservation Service provides support for research and planning activities on approved RC&D projects. The work is coordinated by the Washington office through five field program offices. The field locations are Little Rock, Arkansas; Stillwater, Oklahoma; East Lansing, Michigan; Upper Darby, Pennsylvania; and Logan, Utah.

A total of 15 professional man-years is currently devoted to the overall research effort.

PROGRAM OF STATE EXPERIMENT STATIONS

The State stations have no research classification specifically in this area.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Inventory and Economic Analysis of Watershed Work Plans

By conducting an annual inventory of the basic data contained in PL 566 watershed work plans, ERS continues to accumulate a storehouse of pertinent facts which enables it to engage in systematic analyses of the relevant economic elements and planning phases of the watershed program. These annual inventories help to answer questions about small watersheds.

The latest inventory of basic watershed data covering national total and averages of damages, benefits, costs, and related data--some of it on a regional basis--summarizes information taken from 635 project work plans authorized for operation as of June 30, 1965. The annual inventory of basic data within groupings of watersheds having similar characteristics helps technicians improve planning procedures for ongoing and emerging PL 566 projects.

B. Appraisal of Economic and Institutional Impacts of Installed Watershed Projects: Pilot Watersheds and Washita River Basin

Work on pilot small watershed projects was authorized in a 1953 appropriation by the Congress. The purpose is to demonstrate the feasibility of combining soil conservation measures with upstream structures to reduce frequency of flooding. Joint ERS-SCS long-term appraisals to evaluate the effects of watershed installation improvements are conducted on seven projects, namely: Plum Creek, Kentucky; Six Mile Creek, Arkansas; East

Willow Creek, Minnesota; Honey and Mule Creeks, Iowa; Upper Rio Hondo, New Mexico, and Kiowa Creek, Colorado. Results of these appraisals are applied to methodological studies and evaluation of recreation benefits.

Evaluation studies on the Honey Creek project reveal that average annual benefits from project measures installed between 1954 and 1960 total $20,290. About 72 percent of this is attributed to conservation benefits; the remainder being about equally divided among floodwater damage reduction to crops, roads, and bridges; intensified land use; reduced sedimentation damage; and prevention of gullying. The improvement in wildlife habitat associated with dual-purpose structures stimulated a combined increase in fishing and hunting amounting to about 2,700 visits.

Reduction in floodwater damages to agriculture in Plum Creek was estimated to be $9,399 annually; $4,783 in crops and pasture, and $4,616 in other agricultural damage. However, no intensification of land use benefits from flood risk reduction could be identified. Gross returns from sales of crops, livestock and livestock products, computed for all farms having 50 percent or more of their land within the watershed, increased by nearly $8 per acre of total farmland between 1955 and 1960.

Land treatment measures applied so far to farm lands in the East Willow Creek project have more nearly achieved the goals set forth at the time of planning than have other features of the plan. Shifts in rotations made in conjunction with applied conservation practices have permitted more intensive crop rotations. The amount of soil lost by sheet erosion, fortunately, however, also was reduced at the same time. Net farm income in the watershed increased more than $130,000 per year following installation of project measures. This gain was due to higher crop yields, more intensive uses of cropland, and larger numbers of livestock.

Collection of data relating to land use, yields, production, and management practices was completed for the 1964 crop year in the Six Mile Creek project. These data were summarized and included in the 10-year aggregation of data analyzed and evaluated to identify changes in the watershed during the last 10 years. Economic conditions external to the project area were examined to identify causes for divergence between actual and planned developments. Present watershed planning techniques fail to take into account economic activities which are exogenous to the area under study.

A survey of flood damages which occurred during June 1965 in the Upper Rio Hondo project was completed, and a preliminary report was prepared in cooperation with the SCS. The report includes estimates of damages to land and to fixed improvements.

Data collection for the evaluation studies of the Kiowa Creek project will be completed in calendar year 1965. A preliminary draft report will be available about April 1966. A cloudburst on June 17, 1965, produced from 3 to 9 inches of rainfall over much of the area. Of the 60 floodwater retarding structures, 27 had flows over emergency spillway ranging to 3½ feet in depth. An additional 14 received major amounts of runoff. Some 26 farms were damaged by the floodwaters. About 550 acres of cropland and 1,000 acres of pasturelands were inundated. Major sediment or erosion damages occurred on 380 acres. Preliminary estimates of damages from this flood amounted to $70,000 for with-project conditions. No estimates of without-project damages or project benefits have been made.

Work is progressing on a field survey of the Mule Creek project. Field work is being done by the SCS, with ERS providing assistance in the economic analysis.

Economic studies on the Washita River Basin, Oklahoma and Texas, are made to identify and evaluate physio-economic relationships affecting the design and implementation of watershed development and management. The Washita River Basin is one of 11 designated for upstream flood control and soil erosion prevention projects by the Flood Control Act of 1944. It contains 6,500 square miles of land area of which more than 90 percent is within the State of Oklahoma. Research is conducted at the Watershed Economics Research Laboratory, Stillwater, Oklahoma.

An investigation of benefits from irrigation water in various farm resource situations was completed in the past year. Budgets for irrigated crops were developed and published. The results have been submitted to the Soil Conservation Service and reported at two meetings with State soil conservationists. General conclusions were (1) very little shifting of crops from upland to bottomland resulted from irrigation; (2) the high level of water application was optimum for all crops; (3) cotton and alfalfa were the most profitable irrigated crops; (4) feeders were the only class of livestock that increased in numbers as a result of irrigation; (5) estimated total labor requirements would increase 7.35 man-hours per irrigated acre; (6) estimated total water required per irrigated acre was 1.4 acre-feet; (7) estimated total capital required would increase $57.15 per irrigated acre; and (8) the average net value of water delivered to the farm gate was $7.30 per acre-foot.

An analysis of changes in land use resulting from flood protection has been completed. A draft bulletin has been submitted to the Soil Conservation Service and results were also reported to State soil conservationists. Three comparable pairs of protected and unprotected watersheds were examined to determine differences in intensity of land use. Two pairs showed differences, at least, partly due to flood

protection. No significant differences in intensity of land use were found in the other pair of watersheds. Reduction of the flood hazard could induce some profitable changes in land use. Major changes indicated were cotton and wheat shifting from upland to bottomland, accompanied by increases in temporary pasture, small grains, and sorghum on the upland. Few increases in alfalfa acreage were indicated.

A flood damage-land use study covering the central Washita Basin was initiated. Data collected from farm operators concerning land use, yield, production practices, and flooding have been summarized. Evaluation of the benefits from reducing crop and pasture damage and from land enhancement will be continued for 5 years using the same 450 sample points.

Institutional features affecting watershed development projects are being studied to identify socio-economic characteristics of watershed organizations that promote rapid progress.

C. Development of Methodology and Techniques for Selected Economic Evaluations

Special evaluations of the economics of outdoor recreation were completed during the reporting year. One study was designed to answer questions concerning the effect of selected variables upon the intensity of use of publicly and privately operated water-oriented recreation areas in the United States having lakes of 10 to 500 acres. Public recreation supplied a wide range of recreation opportunities including picnicking, camping, fishing, hiking, swimming, and sightseeing. For all regions studied, the intensity of recreation use diminished as the area of water surface increased. Nationally, the most intensive use of water surfaces was found at reservoirs ranging from 10 to 24 acres. Recreational planners will need to examine specific situations in each area. This study should provide valuable generalized relationships for planning recreational use of proposed small reservoir areas.

An economic analysis at 119 fee fishing lakes was completed in Pennsylvania which charged fees to users. The firms had an average of 2,068 visits by fishermen in 1962, yet the median number was between 500 and 600 visitors. Only 45 of the 89 firms with sufficient data for income calculations had cash incomes larger than cash expenditures. After depreciation and interest on the investment were deducted for the firms, only 26 had returns to family labor and management. Only 12 of the 26 firms had a sufficient residual to pay their own family labor and management a rate as much as $1 per hour. In some instances, the firms lost several thousand dollars. Further study of fee-fishing enterprises as a phase of commercial recreation is required to determine the variables favorable to successful operation. Diversification in complementary services

apparently added to higher net returns. This tendency should be studied further.

D. Secondary Impacts of Watershed Resource Development Projects on the Local, Regional, and National Economies

The goals of project development frequently include objectives of increased national income, regional growth, and economic stability. Economic impacts of resource development are not limited to primary benefits when contributing to these objectives. Thus, resource development projects should be evaluated in ways that permit one to identify all benefits and costs by sectors of the economy. Consequently, increased emphasis is being given to analysis and understanding of secondary impacts.

New studies to appraise secondary economic impacts were initiated for two areas in Pennsylvania. Tioga, Crawford, and Mercer Counties are involved. Major effort was on collection, assimilation, and evaluation of available statistical data. Information concerning employment, sales, and income were collected for over 20 different industrial classifications. Income percentage factors for in and out of county employment by industry groups were computed and averaged for the area.

Sector comparison analysis of existing input-output studies will be continued to compare the stability of coefficients for various geographic areas. A synthetic input-output model for use in appraising economic impacts of watershed projects is needed. Further analyses will try to develop operational methodology for evaluating economic impacts of proposed projects in a planning framework.

E. Development of Planning Criteria, Economic Standards, and Analytical Methodology for RC&D Projects

Research support for the RC&D program is carried out in four major areas: preoperations planning, evaluation of project measures, program assistance in Washington, D. C., and evaluation of economic impacts occurring in project areas.

Socio-economic data have been integrated into "statistical profiles" for the 10 currently authorized projects. This information provides a comprehensive view of the status and trends in the economy of the project areas and documents preproject conditions.

Studies were completed on the feasibility of alfalfa dehydrating plants. The plants would provide new market outlets for forage produced as a result of crop conversion programs in the Oregon and Idaho-Washington project areas. A feasibility study of chili pepper seed production has been completed for the New Mexico project. A study of wood shavings

utilized for livestock bedding in Western areas has been initiated. Studies of recreation development are underway in New Mexico, Georgia, and Vermont.

Evaluations of economic impacts resulting from project operations are an important source of "feedback" information required for continuing evaluation of program effectiveness. The selection and adaption of methodology appropriate for the measurement of income and employment effects of project programs has progressed. Basic information on land ownership, values and taxation has been compiled for a reservoir impact study in the Pennsylvania project area. This study will be completed after the adjustment period has elapsed.

AREA NO. 11. WATERSHED PROGRAM ANALYSIS

PUBLICATIONS-USDA AND COOPERATIVE PROGRAMS

B. Appraisal of Economic and Institutional Impacts of Installed Watershed Projects: Pilot Watersheds and Washita River Basin

Cook, Neil R., Effects of Upstream Flood Protection on Land Use with Special Reference to the Upper Washita River Basin of Oklahoma, Stillwater: Oklahoma Agricultural Experiment Station in cooperation with Resource Development Economics Division, ERS, U. S. Department of Agriculture Processed Series P-501, 1965, 28 pp.

Watershed Program Evaluation, Honey Creek, Iowa. ERS-SCS, USDA, ERS-204, 31 pp.

Watershed Program Evaluation, East Willow Creek, Minnesota. ERS-USDA, ERS-231, 31 pp.

Daugherty, Arthur B., Watershed Program Evaluation, Plum Creek, Kentucky. ERS-SCS, USDA, ERS-243, 35 pp.

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
RDE 1	Land Utilization			
RDE 1-1	National land use inventory	Washington, D. C. West Lafayette, Ind.	Yes	1-A
RDE 1-2	Economic appraisal of land resource development in the United States	Washington, D. C.	Yes	1-B
RDE 1-3	An economic appraisal of the Federal agricultural land purchase and development program of the 1930's	Washington, D. C.	Yes	1-A

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Line Project Incl. in Area and Subheading
RDE 2	Water Use and Management			
RDE 2-1	Economic appraisal of agricultural water use and supply	Washington, D. C.	Yes	2-A
RDE 2-2	Improved methods for the economic evaluation of land and water resource development projects and programs	Washington, D. C.	Yes	9-A
RDE 2-3	Economic appraisal of humid-area irrigation trends, potentials, and water values	Washington, D. C. Madison, Wis.	Yes	2-A
RDE 2-4	Economics of watershed management	Washington, D. C.	Yes	2-B
RDE 2-5	Economics of land forming for water management in selected Eastern States	Madison, Wis.	Yes	2-B
RDE 2-6	Economic appraisal of irrigation water conveyance systems in California	Washington, D. C.	Yes	2-B
RDE 2-8	An economic study of values of water for irrigation and competing uses in the Upper Colorado Basin *	Fort Collins, Colorado	Yes	2-A
RDE 2-9	Values of water for irrigation in the Willamette Valley	Corvallis, Oregon	Yes	2-A

* Terminated during reporting year.

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
RDE 3 1/	Legal-Economic Aspects of Land and Water Use			
RDE 3-1	Legal aspects of water rights in the West	Berkeley, Calif.	Yes	3A-A
RDE 3-2	Legal aspects of water rights in the East	Madison, Wis. Oxford, Miss. Gainesville, Fla.	Yes	3A-A
RDE 3-3	Analysis of rural zoning enabling statutes and ordinances	Washington, D. C.	Yes	3A-B
RDE 3-4	Economic appraisal of local resource organizations	Washington, D. C.	Yes	3A-C
RDE 3-5	Analysis of the feasibility of easements and protective covenants for guiding rural land use	Washington, D.C. Lincoln, Neb.	Yes	3A-D

1/ The work project RDE 3 corresponds to Area 3A in this report.

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
RDE 4 1/	Land Tenure			
RDE 4-1	Development and analysis of basic farm tenure information	Washington, D.C. East Lansing, Michigan	Yes	3B-A
RDE 4-2	Appraisal of economic aspects of land tenure laws	Iowa City, Iowa	Yes	3B-B
RDE 4-3	Maintenance of information on farm leases	Washington, D. C.	No	3B-B
RDE 4-4	Analysis of the family corporation as it affects tenure and resource use*	Ames, Iowa	Yes	3B-B
RDE 4-5	Economic appraisal of interrelationships between farm tenure arrangements and agricultural production control programs in the Southeast*	Washington, D.C. Raleigh, N.C.	Yes	4-A
RDE 4-7	Analysis of land tenure problems and policies of Puerto Rico	Ames, Iowa	Yes	3B-C
RDE 4-8	Resource returns and tenure adjustments*	Washington, D.C. Urbana, Ill.	Yes	4-B

1/ The work project RDE 4 corresponds to Area 3B in this report.

* Terminated during reporting year, and remaining work transferred to appropriate line projects under RDE 9.

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Line Project Incl. in Area and Subheading
RDE 5	Impact of Urban Growth on Rural Areas			
RDE 5-1 (Rev.)	Economic appraisal of impacts of urban growth on rural land use	Washington, D.C.	Yes	5-A
RDE 5-2	The economics of outdoor recreation as a use of rural land	Washington, D.C.	Yes	5-B

Line Project Check List--Reporting Year October 1, 1964,to September 30, 1965

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
RDE 9	Resource Income Distribution			
RDE 9-1	Analysis of the Great Plains Conservation Program **	Washington, D.C. Fort Collins, Colorado	No	-
RDE 9-2	Analyses of trends in land and other resource income**	Washington, D.C. Ames, Iowa	Yes	4-A
RDE 9-3	Incidences of benefits and costs of land use controls and tenure institutions in the North Central Piedmont**	Washington, D.C.	No	-
RDE 9-4	Effects of tenure institutions and government programs upon resource income distribution in the Central Great Plains**	Fort Collins, Colorado	No	-
RDE 9-5	Identifying and measuring effects of technical, institutional and economic forces upon farm resource income distribution**	Washington, D.C.	No	-

Continued

Line Project Check List--Reporting Year October 1, 1964, to September 30, 1965 - Continued

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in Summary of Progress (Yes-No)	Area and Subheading
RDE 9 Cont'd.				
RDE 9-6	Analysis of income distributional effects of alternative public programs in Southwestern States**	-	No	-

** Initiated during reporting year and/or in process of initiation.